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**INVESTIGATION OF METHODS OF
DETERMINING TERRAIN CONDITIONS
BY INTERPRETATION OF VEGETATION
FROM AERIAL PHOTOGRAPHY**

TECHNICAL REPORT No. 6

**Part III. Interpretation of Vegetation on Aerial Photographs
of the Arctic and Subarctic Regions**

Summarizing and Supplementing Report No. 5

**Office of Naval Research
Project No. 257002
Contract N6-onr-25504**

**Arctic Institute
Catholic University of America
January 31, 1953**

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A contract between

the Amphibious Branch and the Arctic Institute
Office of Naval Research Catholic University of America

Monitored by
Research and Analysis Division
Photographic Interpretation Center
Naval Receiving Station

Office of Naval Research
Project No. 257002
Contract N6-onr-25504

Hugh O'Neill, Chief Investigator

and

Arthur Barwick, Arthème Dutilly, Maximilian Duman, Herbert
Hanson, Robert Heller, Ernest Lepage, William Nagel, R. J.
O'Neill, Richard Shamp, Edward Steigerwaldt, Harold Young
and Vincent Waldron.

ARCTIC INSTITUTE
Catholic University of America
January 31, 1953

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INTRODUCTION

This Part III is an attempt to supply a general means of recognizing and interpreting vegetation from air and ground photographs of the arctic and subarctic regions, in so far as this is feasible for so vast a region roughly estimated as more than one quarter of the total land surface of the earth. One practical means of dealing with these regions is to consider it under three great headings:

Lowlands and Plains,
Mountains,
Shield Areas.

Within each of these three great classes of landforms, patterns of vegetation can serve as useful indicators in judging local terrain conditions from air photographs.

Lowlands and Plains.

Briefly for our practical purposes, the lowlands and plains are the green areas on most atlas maps and ascend from sea level to about 1000 feet. In Canada the plains areas are shown on Map I in Technical Report V. On Maps 6 or 7 in the last section of this part, the great bulk of the USSR, is plains, except for the regions cross-hatched as mountains and the shield areas shown on Map 1b (the Baltic, Anabar and Aldan Shields). This is the largest of the world's plains.

The first section of this part deals with a lowland area in the James Bay Region and illustrates, on Plates 1 to 26, terrain conditions that are fairly representative of a very large

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part of the subarctic lowlands in North America and in USSR.

Mountains.

The mountains of our region are shown on Maps 6 or 7 (USSR) in this part and on Map I, Technical Report 5 (Canada). Section 5 of this part deals with an area in the Canadian Rocky Mountains and shows, in a series of thirty plates, terrain conditions that can serve as an example for mountains anywhere in this region where climatic conditions are not too dissimilar.

Shield Areas

for our purposes are intermediate in character between plains and mountains. They are areas of geologically old, hard rocks, the remnants of worn-down, old mountains. The largest is the Canadian Shield (Map I, Tech. Rep. 5). The best known is the Baltic Shield (Map 1b). In Siberia (Map 1b) are the Anabar and Aldan Shields. Deducing terrain conditions in shield areas from vegetation shown on air photographs has been treated in detail in Tech. Rep. 5, illustrated on 28 plates.

THIS REPORT DOES NOT TAKE THE PLACE OF KEYS OR MANUALS, SPECIALLY PREPARED FOR SMALLER AREAS WITHIN THESE REGIONS.

Obviously a special text or manual and keys adapted to the photography of small areas within the vast region of the arctic and subarctic, will certainly enable the photo-interpreter to work more rapidly and more accurately with photographs of that small area. But the making of so many keys, each one specifically for a small area, requires time and expense far beyond the resources of this project. Further, access to the greater part of this region in the Old World is denied us.

It was therefore planned to avoid long delays and to bring out this report now, even with all its unavoidable short-comings, so as to provide the interpreter with at least this general treatment of the whole region so that he will have at least this much available. It is beleived that with careful study of this report, the photo-interpreter can learn to recognize without too much difficulty, at least some of the features of the greatest military importance in the arctic and subarctic regions, that he can learn many general rules that apply to the whole region and that he can, with common sense, learn to make appropriate modifications and special adaptations in his methods and keys for studying special small areas. Obviously further practice and experience working on photographs is very helpful and very necessary. Keys, manuals and maps cannot supply the want of experience resulting from practice. They are only a means of acquiring such experience.

If and when better manuals and keys, expressly made for smaller and specific areas, are available, the practice and experience that will have been gained in studying and using this report should give the interpreter, a preparation that will help him with the more detailed texts.

Map no. 1 illustrates the arctic region as shown by vegetation at sea level. Arctic vegetation extends much further south on the mountains and is then often called arctic-alpine or alpine vegetation.

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It is so very difficult to obtain any consensus of opinion as to where the Subarctic zone should be delimited on its southern border that we prefer not to use the time and space to discuss it here. VERY roughly it is the southern boundary of Map no. 1. The northern boundary of the subarctic region is, of course, the southern boundary of the arctic region.

Section 2 deals with WHITE OBJECTS in these regions. (Plates XXVII to XXXIV). Everyone is aware of the prevalence of snow and ice but those who have never travelled in these regions are unaware that vast areas above or beyond the tree line have a white or nearly white covering in summer as well as winter. This is caused by a layer of cream-colored reindeer-moss on thousands of square miles on the great plateau of Labrador, the barren lands north and west of Hudson Bay, on large areas in Northern Siberia and Russia, and on high mountains above the tree line.

The military implications are very plain. Such areas of reindeer-moss are treeless and afford practically no cover. In summer, the ground underneath the reindeer moss thaws to a depth of only a few inches to a foot or two. Hence digging trenches or fox-holes is usually difficult or virtually impossible. A fox-hole or trench in such an area in summer soon degenerates into a mud hole. This situation increases the necessity and importance of camouflage, i.e. white camouflage for personnel and equipment in summer as well as winter in such areas.

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A variety of other white objects that might be mis-interpreted are also shown on these plates, notably white or light grey limestone and quartz or other white rock. For further details the interpreter should consult the plates and their captions.

Arctic Beaches

In the arctic, roads are very few and very far between. Travelling conditions overland in summer usually means floundering through slippery mud. Beaches and river banks in general are very important, sometimes the only routes of travel in summer. Hence landing conditions on beaches in the arctic and subarctic are of very great importance and are illustrated here by Plates XXXV to XLV.

The Project Director here presents a new method of interpreting beaches from air photographs on the bases of the patterns assumed by the living seaweed particularly visible on photographs taken at low tide and also by the patterns assumed by dead seaweed, driftwood, and the flotsam and jetsam. Other details on landing conditions are also shown on the Plates and described on the captions.

Section 4 of this Part III illustrates terrain in the spruce-birch forest, on nine plates where the great gap between the small scale vertical air photographs (Plate A-1 taken by the 9-lens camera of the Coast and Geodetic Survey) is bridged by a series of nine oblique photographs taken with a small hand camera from a small plane when in the nine positions indicated

by the figures of the aeroplane on Plate I. Plate A-5 gives 4 additional ground photographs. Assembling information from these photographs into a single interpretation should familiarize the interpreter with a variety of aspects assumed by Alaskan spruce-birch forests in association with well-marked glacial landforms on a variety of different scales. Plates A-6 and A-8 were taken from a B-29 primarily for locating on air photographs, areas of stagnant, shallow water, as potential mosquito-breeding areas. These are commonly areas of muck, often impassible.

In connection with these plates illustrating the INLAND spruce-birch forest (north of the Chugach Mts.), the interpreter is referred to Plates XXX to XXXV in Tech. Rep. 5 where the more luxuriant, taller Sitka spruce forest is shown along the COAST.

Also in Tech. Rep. 5, on Plates XXXVI to XXXIX, is shown the white spruce-birch forest coming to the edge of the rock flour beaches of the long estuary near the head of Cook Inlet, Alaska.

Section 6 of this Part deals with the special terrain conditions in peat-cutting areas in so far as was feasible within the time and space at our disposal.

Section 7: Set of Twenty Superposable Maps of USSR.

These maps have been especially adapted for the use of the photo-interpreter to serve as:

1. A general reference on terrain conditions in the USSR.

More specifically, these maps are a source of information to help the interpreter make his deductions from the air photographs.

2. An introduction to the use of maps in ascertaining correlations of any two or more factors of the environment at any given location on the map, as well as non-correlations of factors. This can be most easily seen when any two maps are placed, one exactly above the other, on a transparent (glass or plastic) viewing screen with a bright light underneath. The maps are easily removed from the binder for this purpose. Since all of these maps have been re-drafted especially for this purpose, they are all on the same scale and in the same style of projection. Hence when any two lines on the maps coincide, the correlation between the factors involved, can be considered as very likely. A conspicuous example of this is shown on Map I of the Arctic region, where the 10°C. (50°F.) isotherm corresponds rather well with the tree limit at sea level.

3. The interpreter by studying these maps can learn to think in terms of many factors of the environment and how to connect such factors with his interpretation, e.g. suppose the interpreter is working with a photograph of Novaia Zemlya and is unable to decide if a dark area is trees or merely bushes. An inspection of the map 10 shows this island is far north of the tree limit and deep in the tundra. For this reason the interpreter could correctly rule out the possibility of the

dark-toned growth being a forest.

4. By referring to the set of maps the interpreter can rapidly learn a considerable number of terrain conditions of the area represented in the air photograph he is studying, e.g. to return to Novaia Zemlya, Map 1 a tells him the island was glaciated, (and therefore has at least some unconsolidated sediments, possibly useful in road-building). Map 1 b shows that it is at least somewhat mountainous (it is a continuation of the Ural Mountains). Map 2 shows that it has a cold summer, since its average July temperature is only 6°C (and therefore too cold for the soil to thaw deep enough to support the growth of trees). Maps 9 and 10 show that the soil and vegetation is of the tundra type, confirmed by Map 8 as a region of permanently frozen subsoil, while Maps 16, 17, 18, 19, and 20 show that all of the trees have their northern limit far to the south of this large island.

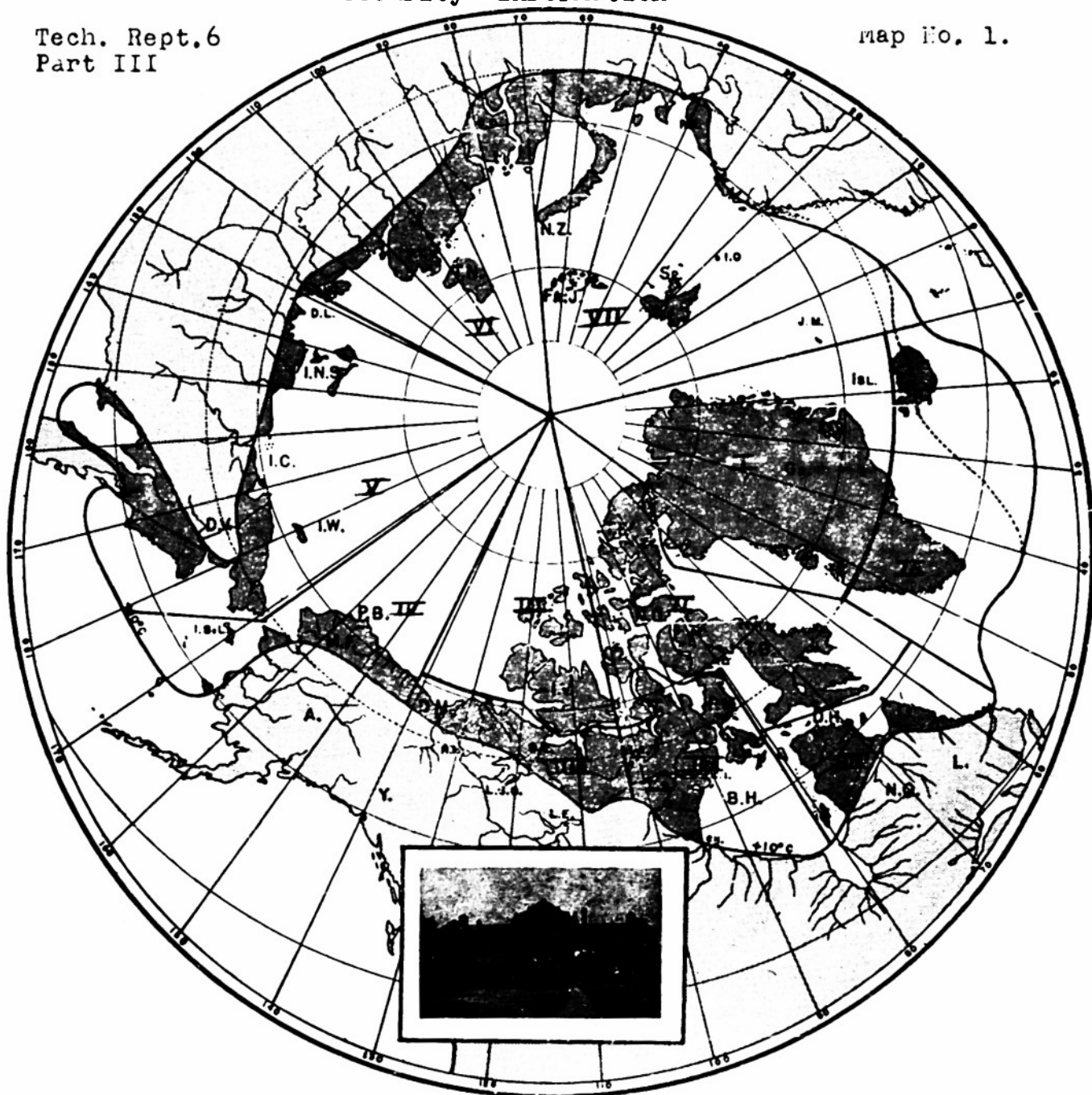
Example of a Deduction Obtainable by Superposing These Maps:

A noteworthy rough correlation is that between the east-west isotherms for July (Map 2) and the natural zones (Map 10) plus the east-west zones of soil (Map 9). On the other hand, a very noteworthy non-correlation is shown when comparing these last two maps with the isotherms for January (Map 3). From this it can be inferred that the July temperature and not the January temperature influences the formation of soil, the distribution of vegetation, the place of the tree-line, etc. This is true.

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map No. 1.



Botanical-Climatic map of the Arctic with southern boundary, on 50° F (10° C) isotherm for July at sea level, which is also the tree-line. The southern boundary of the subarctic region in North America is roughly the southern boundary of the map.

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SOME TERRAIN CONDITIONS
IN THE
LOWLANDS OF THE SUBARCTIC
DEDUCIBLE FROM AIR PHOTOGRAPHS

Text Location:

Drainage Basins

of the

Albany and Attawapiskat Rivers,

James Bay.

Ground Photographs and

Field Information

by

Arthème Dutilly, Maximillian Duman and Ernest Lepage.

August-September, 1952.

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SOME TERRAIN CONDITIONS IN THE LOWLANDS
OF THE SUBARCTIC REGIONS.

Test Location: Drainage Basins of the Attawapiskat and
Albany Rivers, James Bay, Canada.

In general, for purposes of interpreting vegetation from air photographs of the arctic and subarctic regions, it seemed most practical for our purposes to consider this vast circum-polar region primarily under three great divisions of land forms viz.

Flat-lands (mostly lowlands),
Mountains,
Shield Areas (mostly plateaus).

In this section, comprising Plates I to XXVI there is illustrated a low-lying plain, with vegetation and topography similar to much larger areas in Poland and the USSR.

In marked contrast to mountainous regions, the slope of the terrain is relatively unimportant, while the height of the water table is by far the most important factor influencing travel conditions in the summer. A difference of a few inches, not feet, in the level of the water table causes a profound difference in the vegetation, e.g. the average difference in water level between a black spruce bog and a neighboring sedge marsh is commonly no more than a few inches. In such areas vegetation is an extremely sensitive indicator of water table.

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This is of very great importance in interpreting air photographs, since it is so very much more accurate a means of judging terrain conditions in regions which are far too flat to show any differences in elevation on stereo photography.

Probably the best means of judging conditions of travel in lowlands from air photographs is the recognition of the pattern of vegetation. But all judgments of travel conditions must take into consideration the season of the year. This has a most profound effect on travel conditions and must always be used in conjunction with the vegetation, thus, in the winter, the sedge marshes are the best routes of foot travel (i.e. on snow shoes) and are easily crossed by tracked vehicles. On the contrary, in summer, they are virtually impossible for any kind of travel.

In the thawing season in spring when the rivers are full of floating ice, and the land almost everywhere has turned into mud, travelling except by air, is at a stand-still. In such regions of Canada, Siberia, Poland, etc., the inhabitants are resigned to this state of affairs and plan their transportation accordingly.

Dog-sled travel is easiest and best when the severe temperatures of winter give way to slightly warmer temperatures (in March) because then the ice and old snow are not so hard and sand-like on the rivers.

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Lowlands- 3

During winter or summer, the best routes of travel and the most used are the rivers. If however, land travel must be used IN SUMMER, then the banks of the rivers, and MOST ESPECIALLY THE SOUTH-FACING BANKS are the best routes of land travel.

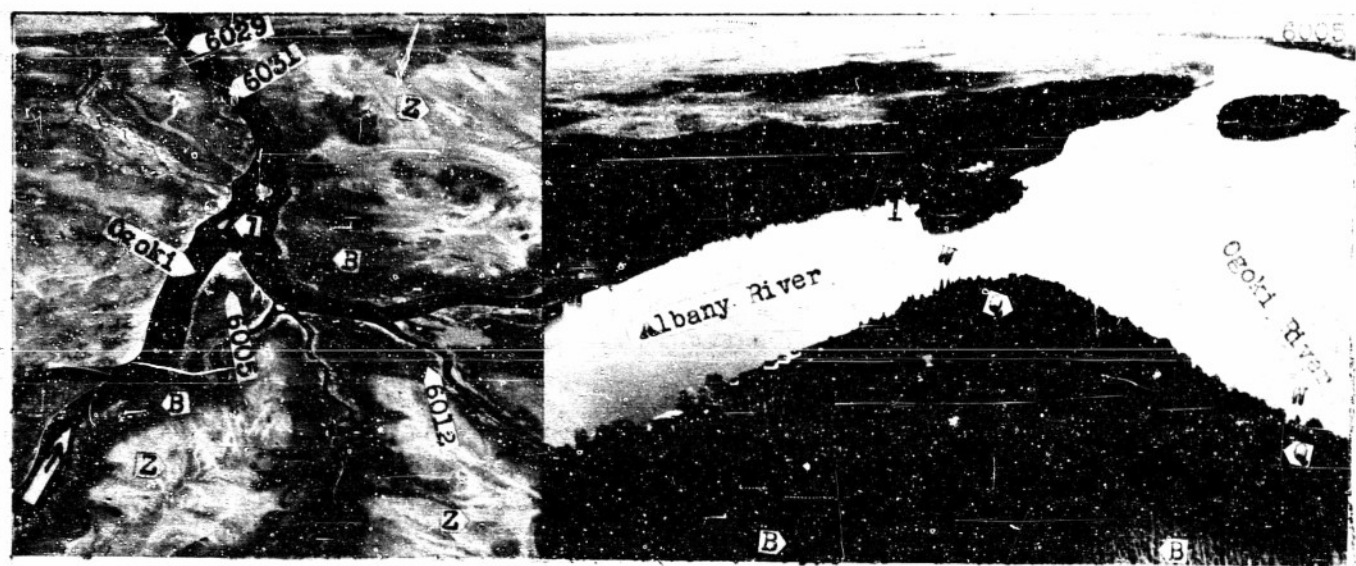
In the summer, the swamps (i.e. the wet forests) are very poor routes of travel, better however than the sedge marshes. However, they must be considered in many regions as the only source of road-building material as very commonly there is no source of gravel or rock except at great distances or at great depths.

Where such a region must be crossed, a corduroy road, made of logs commonly laid cross-wise, on the roots of the trees, will serve many purposes and may last a lifetime, the preservative acid waters of the bogs and the low temperature of the soil and water, retarding decay of the wood.

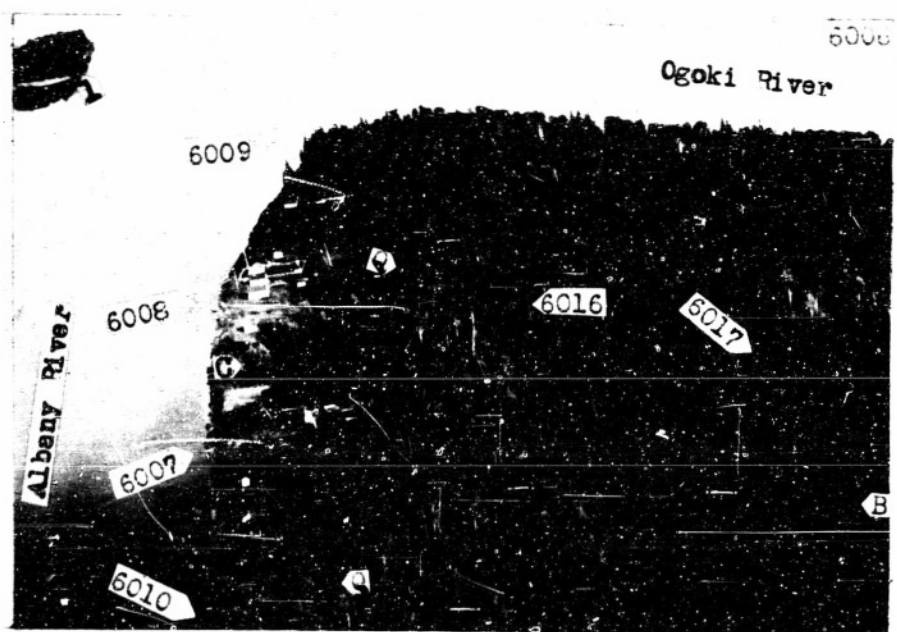
As regards the forests in winter, since they are so much less open than either the frozen rivers or the frozen marshes, they are not routes of travel for tractors. However for snow-shoe travel in the severe cold of winter, the spruce forests are preferred if the growth is not too dense for the reason that they afford shelter from the winds and always feel as if they were much warmer than the open, wind-swept marsh areas. As regards camping sites, the spruce forests are always to be preferred, for the obvious reason that there is both shelter and fuel there.

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Albany River Series. I. Air Panchromatic Oblique Photographs of
Ogoki, at the Junction of the Ogoki and Albany Rivers, Aug, 13, 1952



The left-hand photograph, Roy.Canad.Air Force T 143 L-36, less than 1/40,000; the right, 6005, shows Ogoki and the river junction.



(1) is the same island opposite Ogoki shown on all three photographs. (W) is white spruce always an indicator of better drained soil.

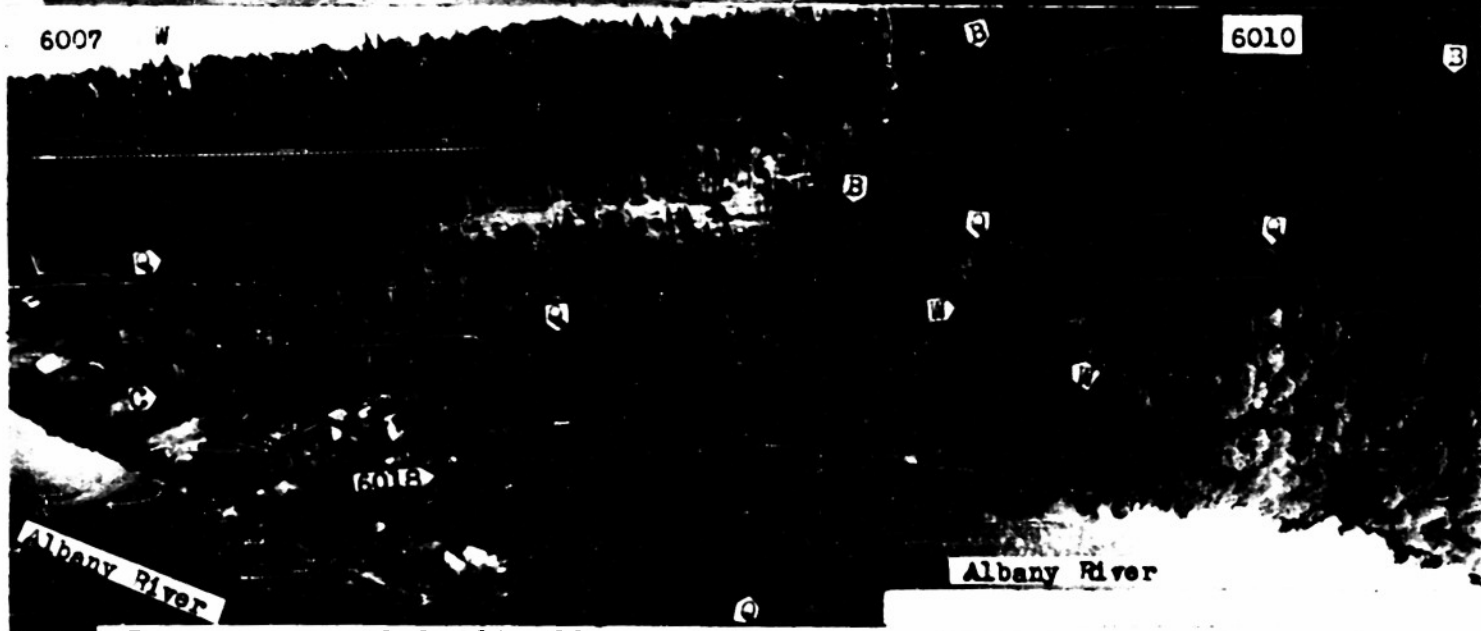
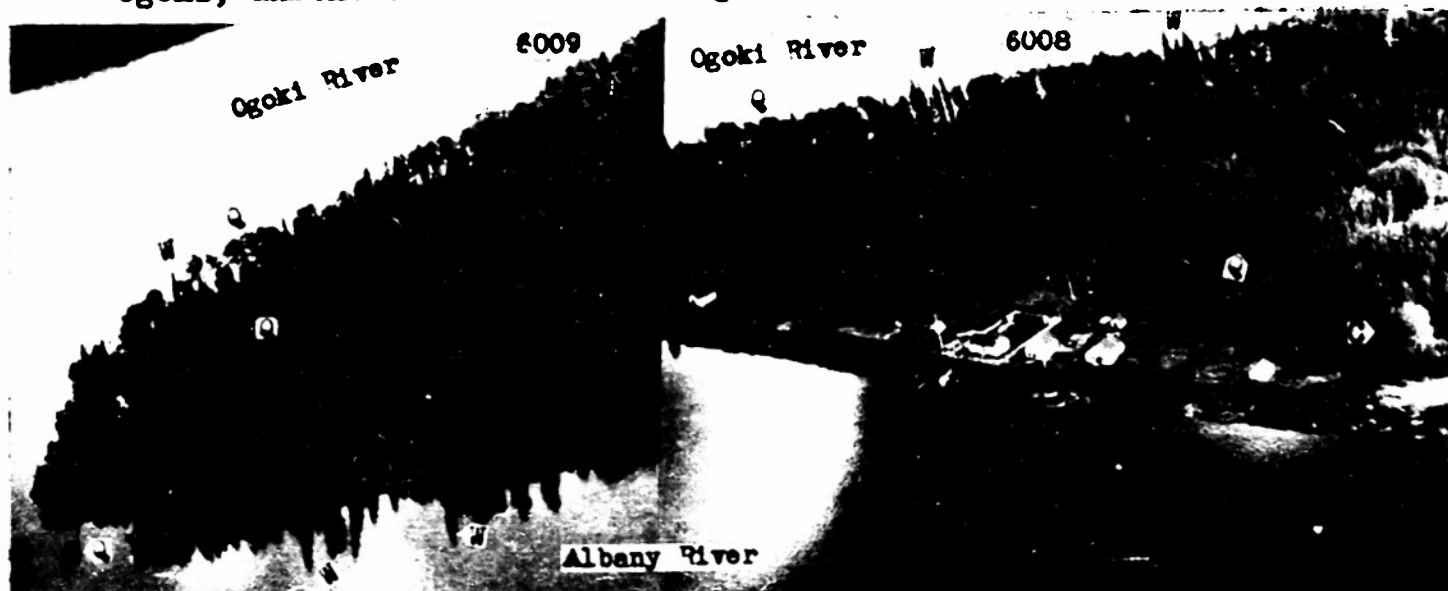
This and the following 7 plates, the Albany River Series, illustrates one type of terrain conditions in the subarctic region, i.e. a flat area of many thousands of square miles in both the Old and New Worlds, where the earth's surface is a deposit of clay to the depth of many feet, that remains badly water-logged throughout the summer to such an extent that no travel for any considerable distance is practical except by water or by air. On land the best travelling is on the banks of the rivers, unfortunately interrupted at the mouth of each tributary and each seepage. These drier banks, the only sites practicable for road-building show on even small scale air photographs as very light gray or nearly white strips (averaging 30 feet in width). (B) the darkest areas, are wet stands of black spruce; (Z) the light gray areas, are marshes, the largest and most impassible areas in summer. (Q) is aspen. (C) is Cottonwood.

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PLATE I I

Albany River Series. II. Air Panohromatic Oblique Photographs of Ogoki, and the Junction of the Ogoki and Albany Rivers, Aug. 13, 1952.



Photographs 6009, 6008, 6007 and 6010 show additional details of the locality shown on the preceding plate. This is the type of the drier localities which form only a very small part of the total area of tens of thousands of square miles of flat, clayey areas in the subarctic regions of Canada, Siberia, Russia, Poland, etc. Only these drier banks of rivers and lakes are places where man can dwell and farm. The great bulk of such areas is swamp and marsh (muskeg) offering the greatest difficulty for military operations in summer. In winter, when frozen, the marshes are readily crossed by tracked vehicles ("snowmobiles") in going from one frozen lake to the next. Such frozen marshes are the only areas suitable for snowshoe travel. 6009 is an example of where images in water are more easily recognizable than the objects themselves. (B) black spruce; (C) cottonwood; (Q) Quaking asp; (W) white spruce. The last three of these trees indicate the dry river banks.

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Albany River Series. III. Panchromatic Ground Photographs of Ogoki,
at the Junction of the Ogoki and Albany Rivers, Aug. 14, 1952.



6016, 6017, 6038, 6018 show further details of the locality shown on the preceding two plates. 6016 shows an area burnt about five years ago (notice the charred stumps 2). Contrary to a very common error, the vegetation that invades such a "burn", e.g. (F) fireweed, (g) grass (*Calamagrostis canadensis*, the commonest grass in subarctic N. A.) indicate the type of terrain just as did the original forest which will eventually re-establish itself. (Q) The quaking asp is the tree that most commonly invades the relatively drier areas after fire. Stands of it always show as a much lighter tone of gray than the spruces, and commonly forms 90% or more of the trees on the banks. Commonly associated with the aspen is a dogwood, the red osier (D). (A) is an alder indicating the wettest spot on 6016. 6038 shows a poor place for landing on the bank of the Ogoki River since there is a marsh of shallow water and mud indicated by a zone of sedges (c), a zone of willows (S) to traverse before reaching the dry bank indicated by the zone of (A) aspen. 6017 is an unusually tall stand of black spruce growing in a layer of humus a foot thick overlying a hardpan of the everpresent clay (B) is black spruce.

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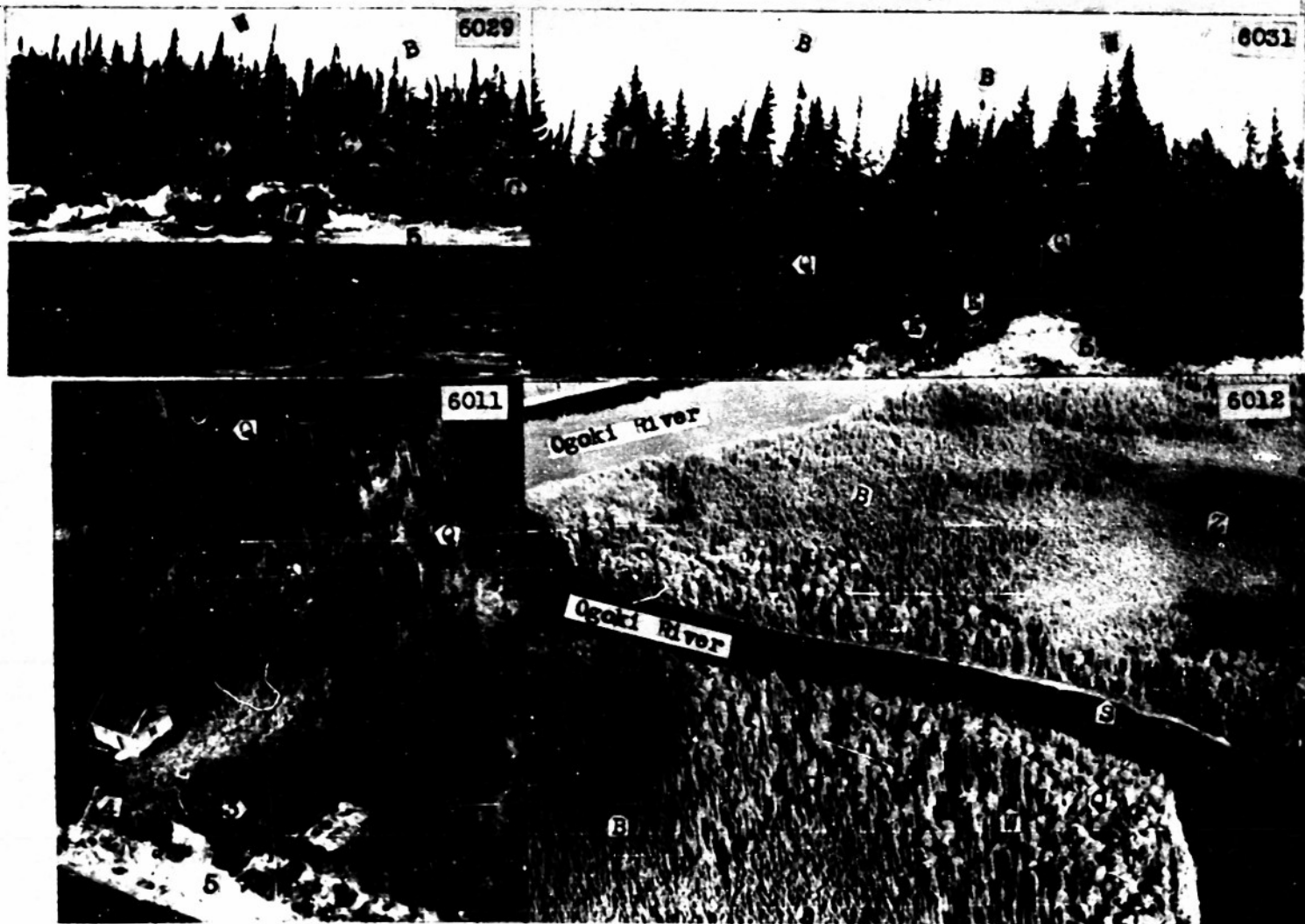
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PLATE IV

SECURITY INFORMATION

Albany River Series. IV. Air Oblique and Ground Panchromatic Photographs of the Banks of the Ogoki and Albany Rivers, Aug. 13 and 15, 1952.



6029 & 6031 show black spruce (B) indicating wet background; white spruce (W), aspen (Q) and cottonwood (C) indicating the well drained bank. On 6029 the fallen white spruce indicates an eroded bank. The wind causing the waves on the river is also exposing the lighter undersides of the leaves of the cottonwood (C) making them appear very light gray. The silver-leaved bush (Eleagnus) (E) in 6031 indicates a dry sunny bank. The leaves of this bush and several of its common relatives in Russia & Siberia are covered with minute silvery scales of high reflectance. Hence these bushes appear white on photographs. The house, clearing and garden (3) of an Ojibway indicates a well-drained bank. The steepness of the clay bank is indicated by the ladder (4). Although the clay (5) is gray to the eye, it appears nearly white on the photograph. Note that sand, sand-bars and gravel are conspicuously absent from this and similar rivers in the subarctic region. 6012 shows a marsh (Z) the poorest trafficability in summer, but of good trafficability in winter. This is the prevailing type of vegetation in enormous areas in the lowlands of the subarctic region of the Old and New World. Black spruce stands (B) are less water-logged than the marshes, and form a transition from marsh to dry river bank. A narrow zone of willows (S) often borders the aspen.

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Albany River Series. V. Stereo Panchromatic Air Vertical Photographs,
Albany River, 86°20'W. 1/40,000. Roy. Canad. Air Force T 140 C-38, 39.



(2) the marshes of deep, soft mud with a growth of sedges and other marsh plants are often more or less covered by shallow water recognizable by the same area appearing nearly white on one member of a stereo pair (e.g. the lower right corner above) and much darker on the neighboring member. The darker areas (B) are black spruce stands indicating soil not as badly water-logged as the marshes. The narrow strips of white or light gray on the banks alongside the rivers are by far the most feasible, and in fact, the only practical overland routes.

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PLATE VI

SECURITY INFORMATION

Albany River Series. VI. Panchromatic Ground Photographs of the Banks of the Albany River, 86° 20' W. Aug. 18, 1952.
Shown on air photographs on Plate V.



6046 shows a mud-bar on the down-stream side of an island. The bar is covered with willows (S). The sedges (c) around its edge indicate shallow water and a very soft bottom. The aspen (Q) indicates that the island is high enough to be well drained.

6048 is a point free of mud, and a good dry place to land, indicated by the aspen (Q). The sedges (c) in the cove on the right indicate soft mud and shallow water, just as they do in 6049. (W) is white spruce.

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Albany River Series. VII. Panchromatic Ground Photographs of the Bank of the Albany River, 86° 20' W. Aug. 18, 1952.
Shown on air photographs on Plate V.

6057



6051



6052



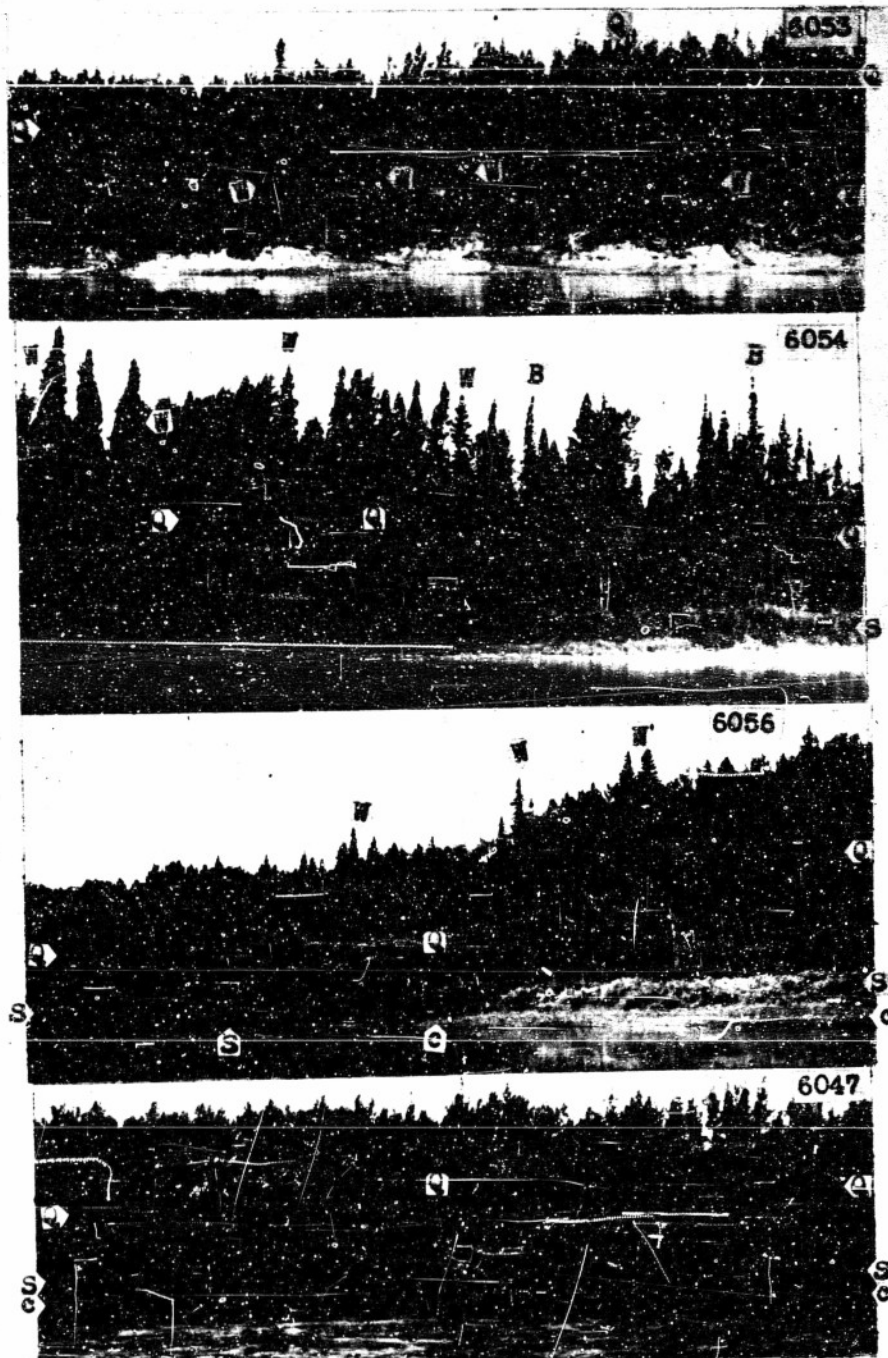
The foreground of 6057 is a mud-bar with sedges (c) indicating shallow water on soft mud; the grass (g) indicates a zone just above the water; the zone of willows (S) is the transition zone to the dry aspen (Q) zone. This pattern of successive zones in the coves is substantially the same in many of the coves in lakes and rivers of this entire region. 6051 shows a similar zonation on a low bank. The same type of zonation, but with alder (A) taking the place of the willows, is shown on 6052. These zones, difficult to recognize on so small a scale or 1/40000, are readily seen on larger scale air photographs. (W) is white spruce.

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PLATE VIII

SECURITY INFORMATION

Albany River Series, VIII. Panchromatic Ground Photographs of the Banks
the Albany River, 86° 20' W. Aug. 18, 1952.
Shown on air photographs on Plate V.



6054, 6056, 6047 all show the common pattern of zonation of the vegetation in coves and along banks of slow-moving rivers. The zone of sedges (c) indicates shallow water and soft mud; the zone of willows (S) is the transitional zone to the dry zone of white spruce (W) and aspen (Q). Black spruce (B) indicates the water-logged forest farther back. The absence of the sedge and willow zones in 6053 shows that the swift current has eroded part of the clay bank.

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PLATE IX

SECURITY INFORMATION

Martin's Drinking River. Stereo Panchromatic Vertical Air Photographs
1/40,000. Roy.Canad. Air Force T 122 C-104,105. Dotted lines and
arrows indicate the direction of current and route taken by the authors.



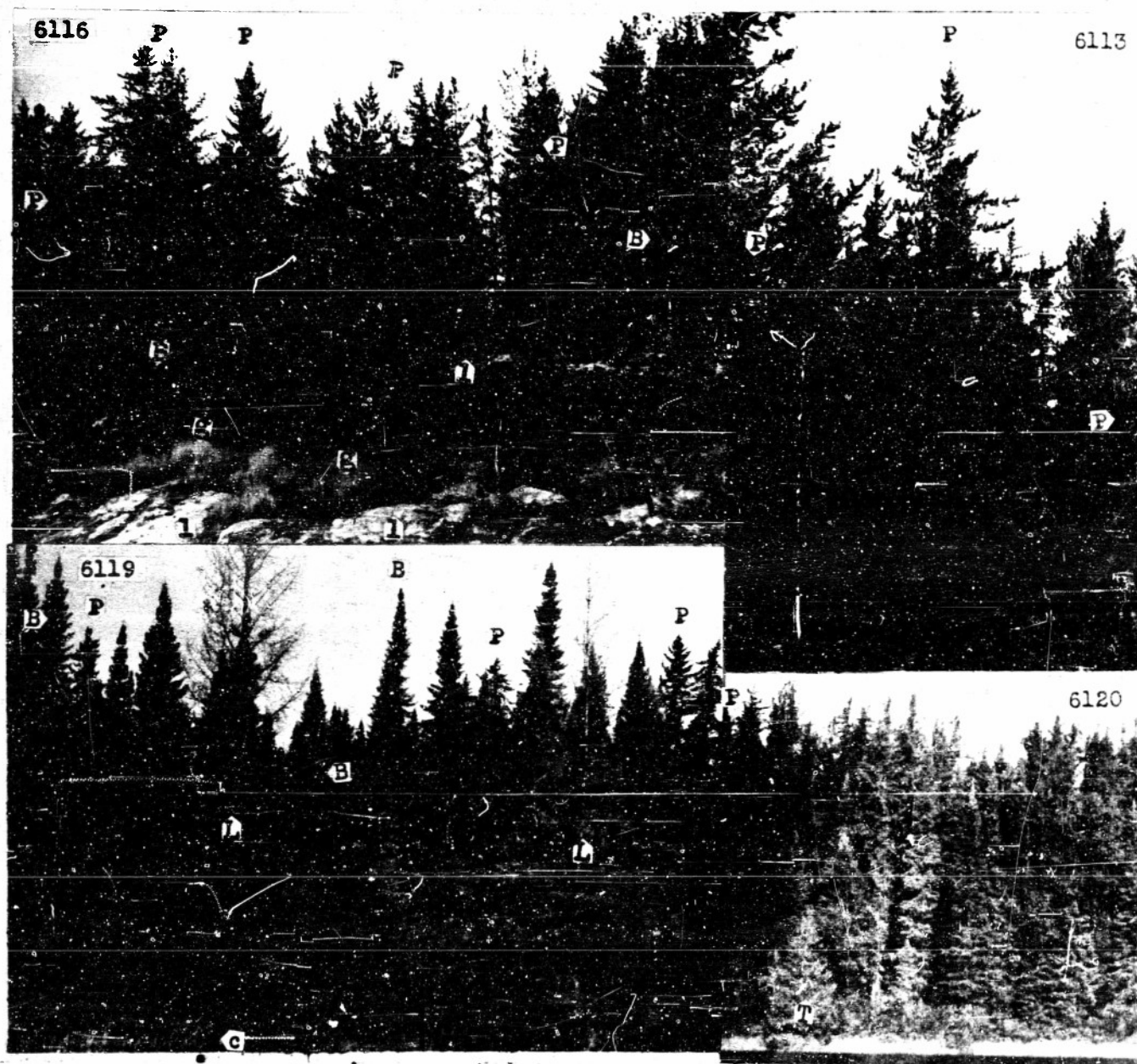
In marked contrast to the preceding 8 plates these photographs show an area where the rock, a granite, makes up much of the earth's surface. Clay covering is absent here. The numerous lakes, surfaced by ice (1), and the low rounded snow covered hills recall landscapes in Lapland, Finland, etc. Dotted line indicates canoe route, arrows indicate direction of current. The nearly black areas are northern scrub pine (P) indicating the driest terrain, (Q) is aspen.

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Ground Panchromatic Photographs of Martin's Drinking River. A drier rocky area not covered by clay, indicated by Northern Scrub Pine. Shown on air photographs on Plate IX. AUG 27 1952



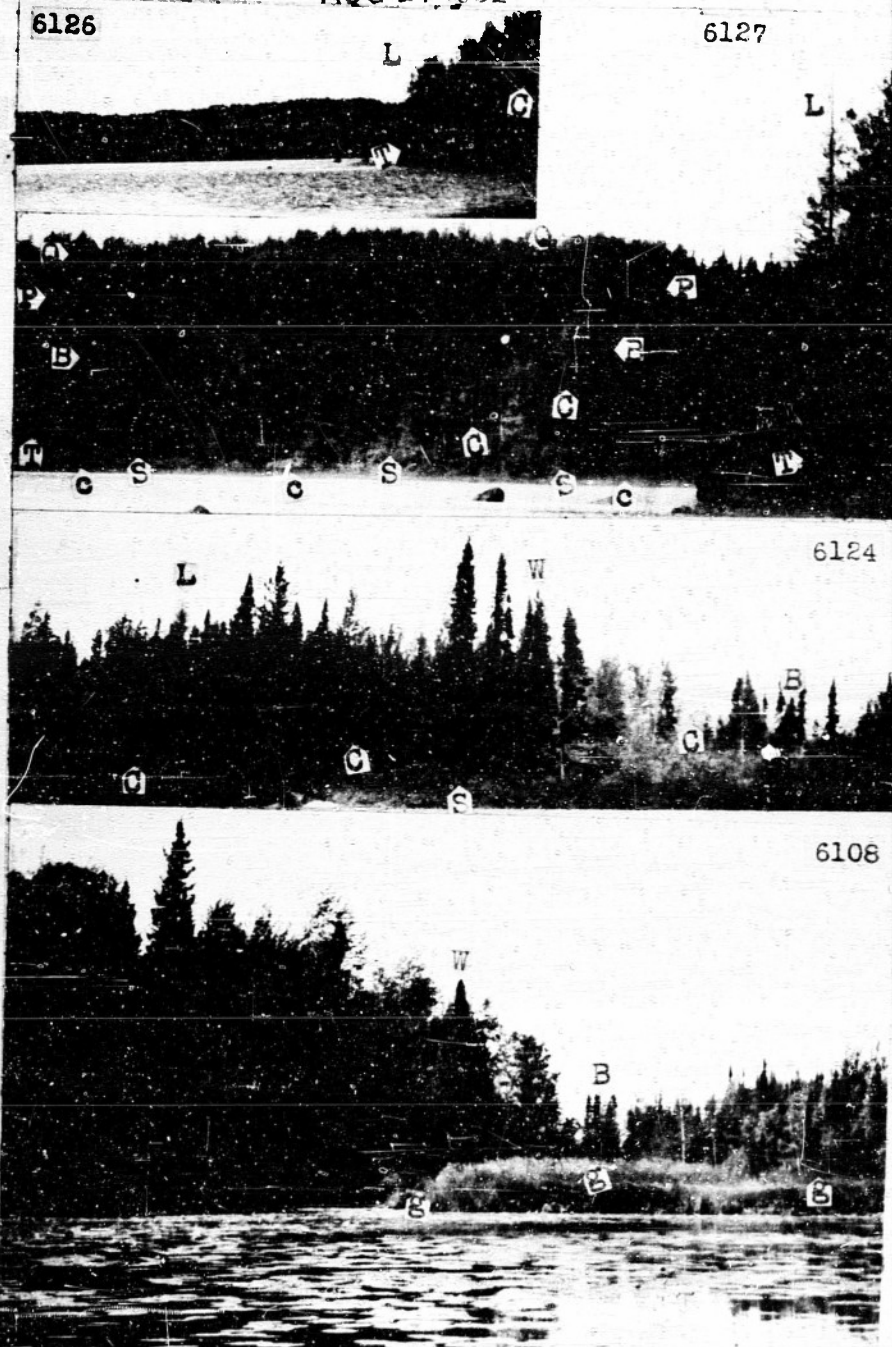
This set of 4 photographs shows the northern scrub pine (P) as an indicator of the driest terrain, in fact it often grows where only a few inches of soil cover the rock (6116). It may be taken as an indicator of the best trafficability under foot in areas such as this. This pine is similar in appearance to its near relative, the Scotch pine (6113) so very common in the Baltic area and northern Europe generally. 6119 shows this pine as an indicator of the drier terrain while black spruce and larch indicate the lower and waterlogged terrain. 6120 shows this pine in close proximity to the northern cedar indicating "Mother Nature" has not read articles in botanical journals stating these two trees do not grow in the same locality. (B) black spruce; (L) larch; (T) cedar. (c) sedge; (g) grass;

and Panchromatic Photographs of Martin's Drinking River. Water-
lilies as an Indicator of Depth of Water. Use of Tele-photo Lens.
on air photographs on Plate IX. AUG 27, 1952

6126 and 6127 (telephoto-
detail) show that the
scrub pine re-
lects the darkest tone
of all the types of ve-
getation in this area.
The top band of trees is
green (Q) probably fol-
lowing a forest fire, the
next band is black
green (B), the middle
band is the scrub
(P). (L) is the
dark indicating water-
logged soil. (T) is
willows, (S) is willows,
(C) is cottonwood, (o)
sedges, (g) is grass.

white spruce.
shows a colony of
lilies whose leaves
are large and in
position are
visible on air photo-
graphs. They indicate still
water of necessity
settles to
soft mud bottom. In
"a maze of
and lily ponds"
the banks of the
river, abruptly
the Russian advance
the Star River toward

Water-lilies



In the New and Old World waterlilies grow in shallow water some-
as much as 5 feet deep. They commonly indicate a soft mud bottom,
recognisable on all but the smallest scale air photographs, and
usually indicate deeper water in the area free of them towards the
edge of the pond or lake, information of value in searching for a
landing place for hydroplanes. Since this is a favorite food of the
beaver, the ravages of this animal where it is common may wipe out this
locally. In the pattern of vegetation the waterlilies always
mark the deepest water, and are concentrically inside the zone of
grasses and sedges.

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PLATE XII

Attawapiskat River at 83°35' W. Panchromatic Stereo Vertical Air Photographs, Scale 1/40,000. Roy. Canad. Air Force. T 145 C 69,70.



These air photographs show a terrain with a relatively shallow layer of clay covering the underlying limestone which appears as outcrops on the banks and islands of this part of the Attawapiskat River. (B) black spruce; (C) cottonwood; (Q) aspen; (H) moist heaths, marshes registering a darker tone of gray than sedge-grass marshes (Z) but having about the same poor trafficability. (9) is pale gray to pale yellow or pale red limestone.

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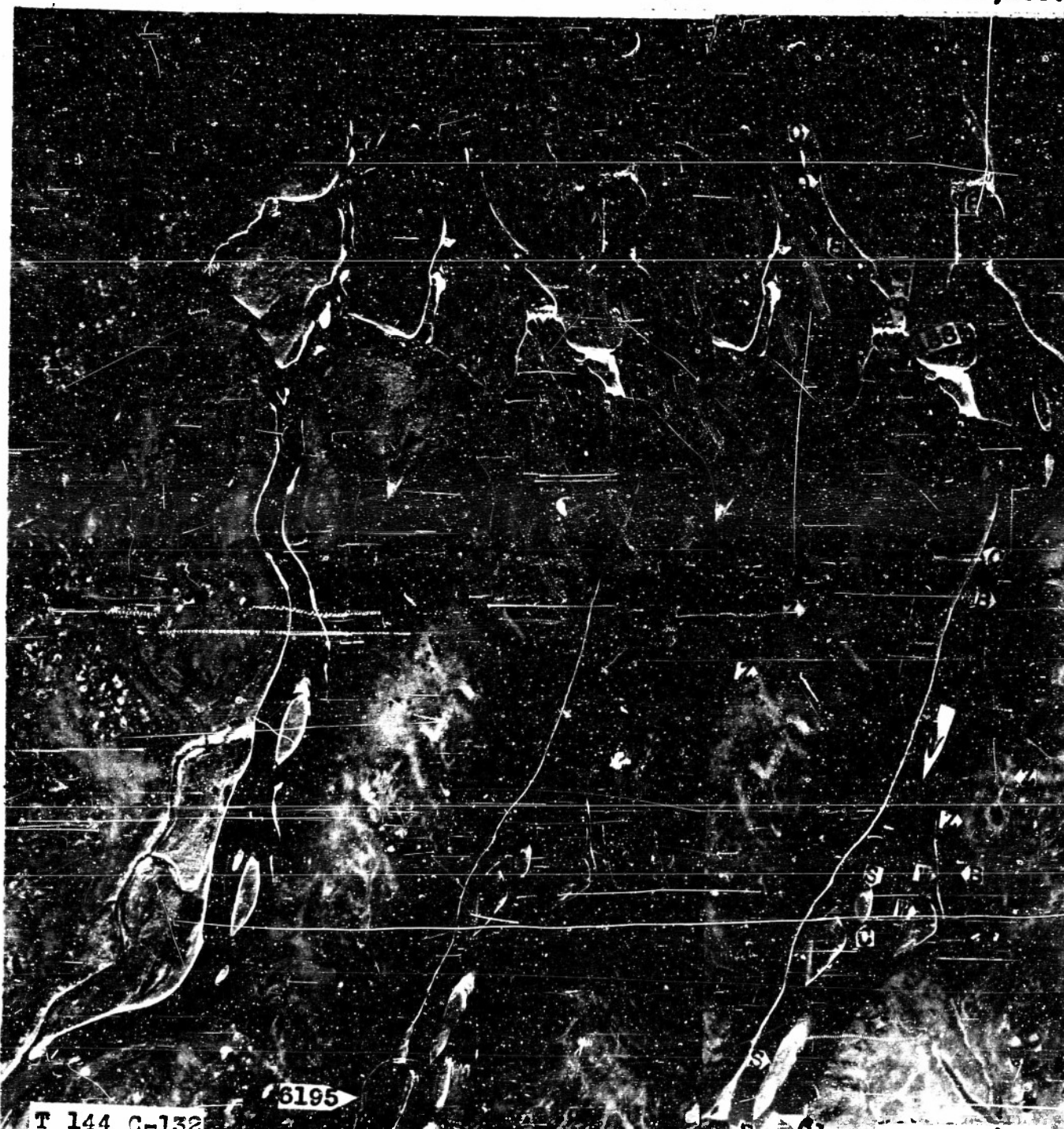
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Ground Panchromatic Photographs Taken along the Ice-scored Limestone Bank of the Attawapiskat River near 85° 36' W., Sept. 4, 1952. Shown on air photographs on Plate XII.



The thin white line band bordering the Attawapiskat River as shown on Plate XII are mostly outcrops of pale gray or yellowish to reddish tinted limestone mostly too narrow and/or too steep to be of use for travel except on foot. The presence of limestone at or very near the surface of the earth affords excellent easily worked road-building material and for that reason makes such an area much less of a military obstacle, i.e. than are areas where rock suitable for road-making is buried under a deeper layer of clay (e.g. such areas as are shown on Plates I to VIII). 6255, the bank of an island and 6256 the bank of the river are scored and scoured off by the blocks of ice in the spring floods. The project-director observed these scratches made by floating ice on the other side of James Bay, e.g. on the island at the mouth of the Fort George River, where the much harder rock, granites and gneiss, is polished as well as scratched. These scratches (striae) can be taken as registering the height of the flood waters while the vegetation immediately above them, commonly a band of willows (pale gray on photographs) where it meets the zone of spruce (dark gray) registers the height of the occasional and exceptionally high flood level; information often obtainable in no other way. (B) black spruce; (Q) aspen; (S) willow bushes; (W) white spruce; (9) limestone, nearly horizontal layers.

Stereo Panchromatic Vertical Air Photographs of the Attawapiskat River at 83° 10' W. 1/40,000. Roy. Canad. Air Force T 144 C 132, 133.

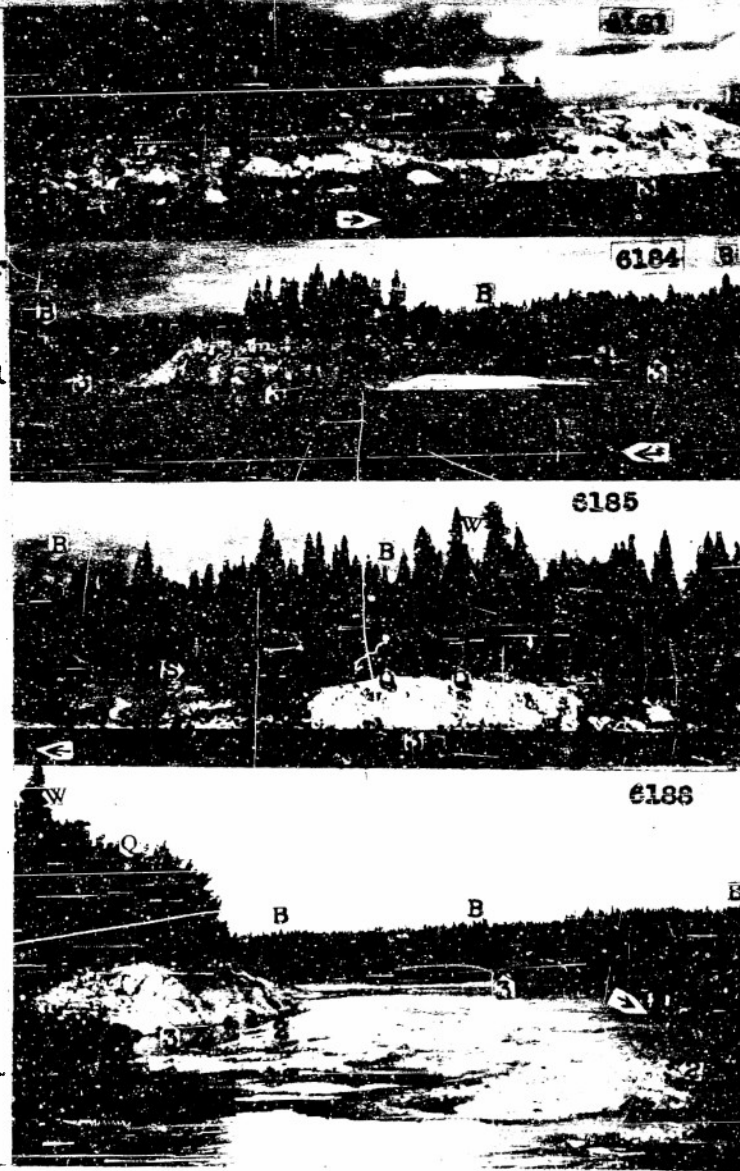


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Here the Attawapiskat, as it cuts through low limestone outcrops forms rapids between the prevailing higher banks than those further down the river, in the region of thick clay deposits. 6185 was taken from the same spot as 6188 but looking a little more to the right. (B) black spruce; (C) cottonwood indicating well-drained subsoil, forms a thin light gray line on the air photograph; (S) willow bushes (*Salix pellita*); (Z) marshes with numerous ponds, areas of the worst trafficability; (8) rapids; 6181 and 6171 could not be conveniently shown on this plate.

These photographs are photographs of gravel bar and limestone banks
the Stikine River at 53° 10' N., Sept. 4, 1958.
See the photographs on Plate XIV.

In ascending this river, the first rapids occur at Forty-mile Rapids (6184, 6185, 6186) the second rapids at Sixty-mile Rapids (6181), which are so named on account of their distance from the mouth of the river. Both locations show where the river crosses the outcrops of limestone. The top of the exposed limestone (3) shows the high water level of the spring floods. The zone of willows (S) shows the highwater-water level of exceptionally high floods. The "gravel" here is more or less rounded pieces of limestone. Here as in the clay capped areas further down the river, the best land travel is along the river banks in spite of the slippery surfaced limestone boulders in wet weather. The limestone shores show very plainly as nearly pure white bands. These are usually so steep as to make difficult walking on them, so much so, that in spite of the obstruction of the alders and willows, usually the best walking is on the top of the banks at the edge of the spruce-aspen-cottonwood forest. Sand-bars are not common in this stretch of the



river, which carries fragmented limestone and clay with only a small amount of sand. Note that the vegetation here is similar to that of the vegetation on the clay cap and that the limestone does cause any change in the vegetation very obvious from an air photograph. 6181, not shown on Plate XIV, shows one of the many limestone islands near Sixty-mile Rapids. 6184, 6185, 6188 show limestone banks of large islands. (A) is alder; (B) black spruce; (C) cottonwood; (Q) quaking asp; (S) willow bushes; (W) white spruce; (2) is a limestone gravel bar. Arrows show which way the current flows.

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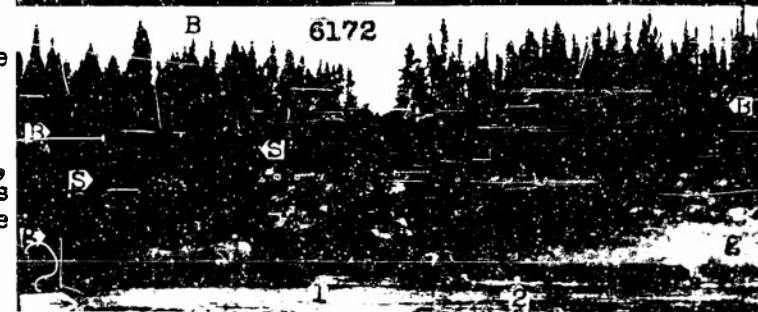
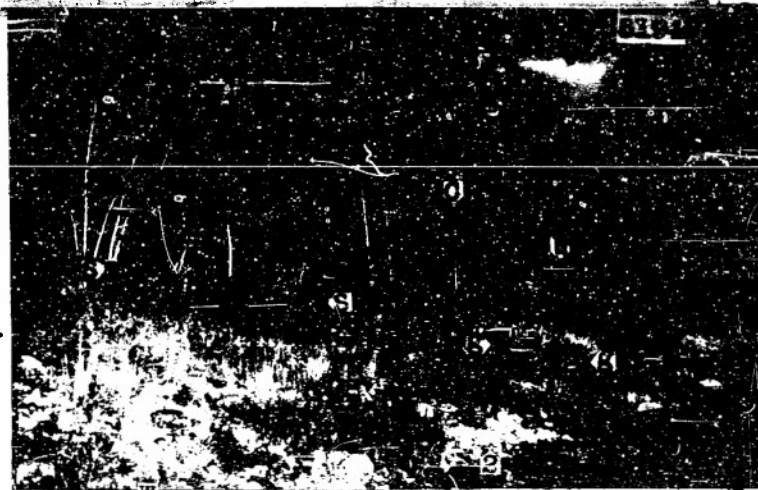
PLATE XVI

SECURITY INFORMATION

Ground Panchromatic Photographs of Stony Banks and Landslides
along the Attawapiskat River at 62° 10' W., Sept. 4, 1952.
Shown on air photographs on Plate XIV.

6172, not shown on Plate XIV, shows a landslide on the clay bank of the river, (1). The stand of black spruce on this bank ten feet above the level of the river, indicates the impervious quality of the clay. If this bank was better drained, instead of black spruce there would be white spruce with usually some cottonwood trees interspersed at the very margin of the bank. Since there is this importance difference in what each kind of spruce indicates, the question has arisen, is it possible to distinguish white from black spruce on photographs. While this is often impossible or very difficult, the author believes that under certain conditions it is possible to make this distinction. The very short hairs on the twigs of white spruce retain dew-drops, rain-drops and frost particles very much better than does the hairless twigs of the black spruce. Consequently photographs taken when the weather is such as to cause this precipitation on the twigs of the white spruce, a distinction can often be made by visual observation, or on photographs. This is clearly shown on 6195 where the white spruce (W) shows a lighter tone than the black spruce (B).

In general the black spruce has shorter, more downward sloping branches, a more scraggy or scrubby appearance. Intermixed commonly with white spruce is the (C) cottonwood (6194); but with the black spruce, the (L) larch, (6195). In Alaska white and black spruce often occur freely intermixed and possibly even hybridized, making a distinction very difficult. However as shown above, a distinction can sometimes and under some circumstances be made. Note that the trees lean in the direction of the current. (S) willow; (g) grass; (2) limestone boulder.



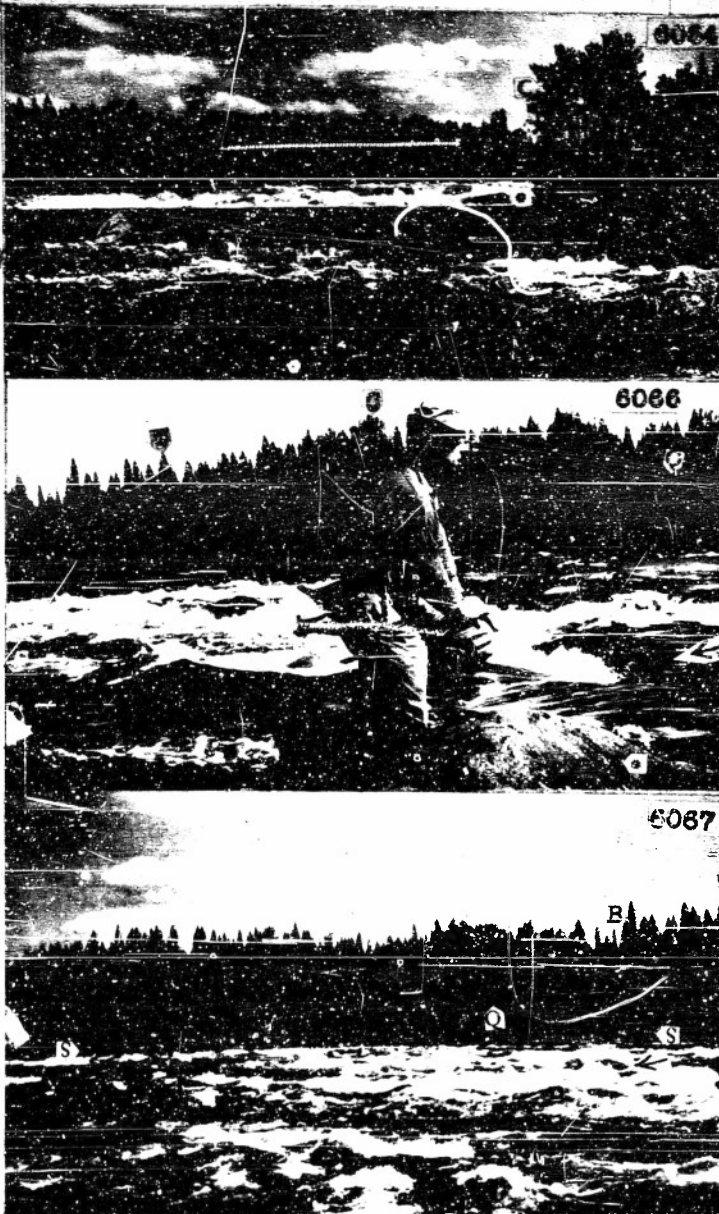
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Ground Panchromatic Photographs of Rapids on the Albany River,
Aug. 19, 1952.

In very large areas of the subarctic and arctic lowlands, e.g. in Poland, central Russia, central Siberia and western Alaska, the rivers are the great arteries of travel for as far as the rivers are navigable, i.e. as far inland as the first notable rapids. However higher up the rivers, the most convenient travel, e.g. for small parties or reconnaissance groups, is often by means of small boats, in this area by means of 20-foot keel-less canoes. (Shorter canoes and keeled canoes are not safe for shooting rapids of any considerable size and should never be used). Further, in glaciated regions with a network of long lakes and interlocking streams, recognizable on air photographs (Plate IX), by carrying canoes (portaging) over relatively short distances, it is possible to travel more rapidly and more conveniently than by any other method in summer. There are two principal obstacles to travelling by canoe; viz, where the water is too swift and where it is too shallow. This and the two following plates show the means of dealing with these conditions.



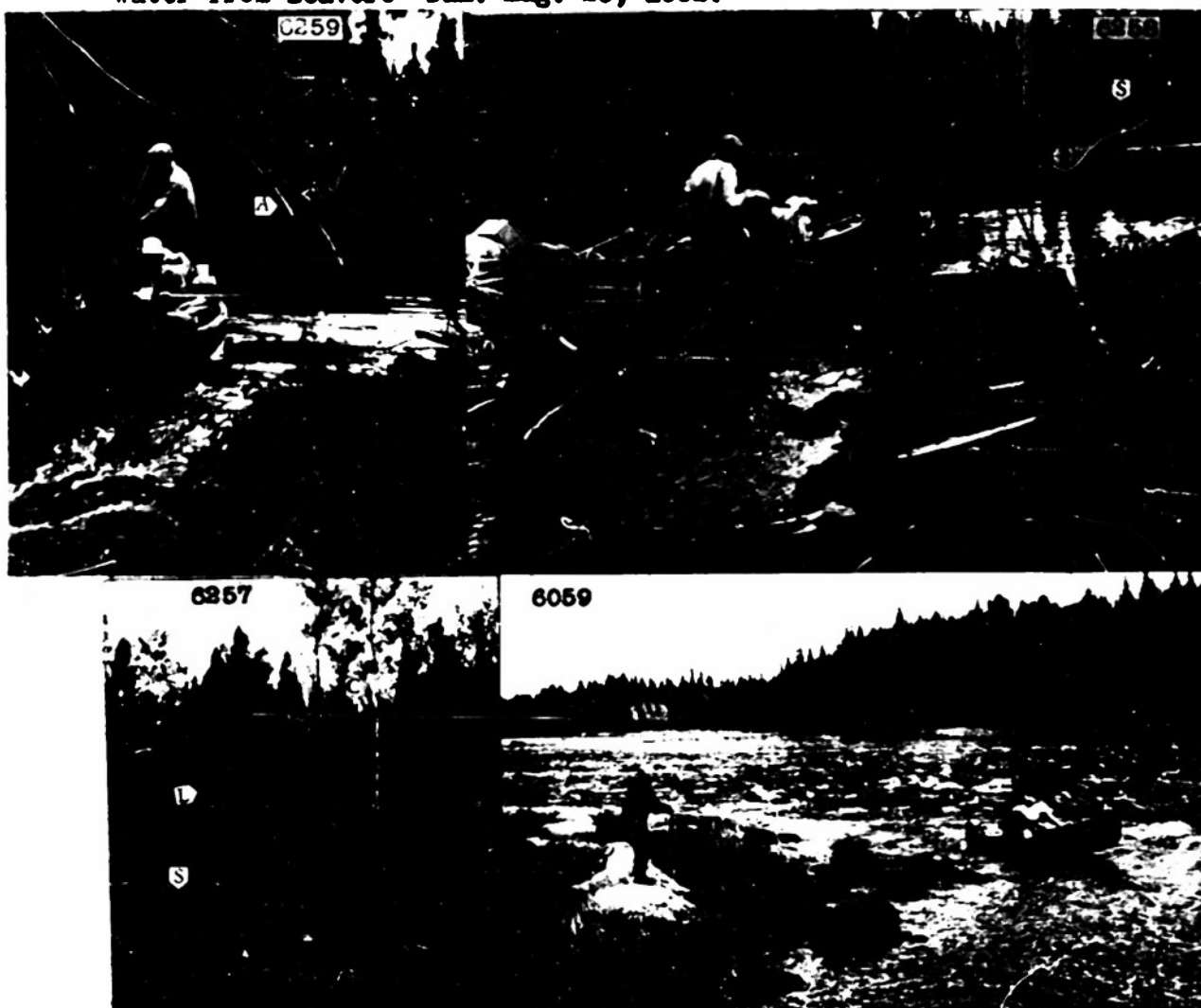
6064 shows a "rapids-ataract", much too violent for any type of boat or canoe. 6066 is a stretch of the river just below the "rapids-ataract". The asterisk (*) on the granite boulder marks the spot furthest upstream to which a canoe can go by paddle, pole or out-board motor. Here a portage about a quarter of a mile long, is necessary. The bank for a portage is usually recognizable (on a photograph) by having a cove (at C and * on 6064), where it is easier to land. (B) is black spruce; (Q) quaking asp; (S) willows; (W) white spruce. Arrows show the direction of current. 6064 and 6067 were taken with the yellow filter; 6066 without a filter.

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PLATE XVIII

Ground Panchromatic Photographs Showing Methods of Canoeing Utilizing Water from Beavers' Dam. Aug. 26, 1952.



6059 shows the use of rope in ascending shallow rapids. Recognizable on air photographs are 6257 shows a beavers' homes (6257) mounds of branches, mud, grass, etc. about 10 to 12 feet in diameter and about 4 feet above the level of the water. The beaver's house can be distinguished from the muskrat's house, which it resembles on photographs by its construction of reeds, cat-tails, grasses but no branches, and its much smaller size, 5 to 6 feet in diameter. The beaver's home, a year-round home, is never found far from aspen and cottonwood (C). The muskrat, introduced in Siberia from this country, has been a great success. Its houses built only for the winter are also recognizable on air photographs. The beaver's well-known habit of building dams can be utilized to save many a weary mile of portaging by treating it as a lock in a canal. 6258 and 6259 illustrate the opening of the dam in order to secure enough water to float the canoe down a water-course otherwise too shallow. (Cont. on Plate XIX.)

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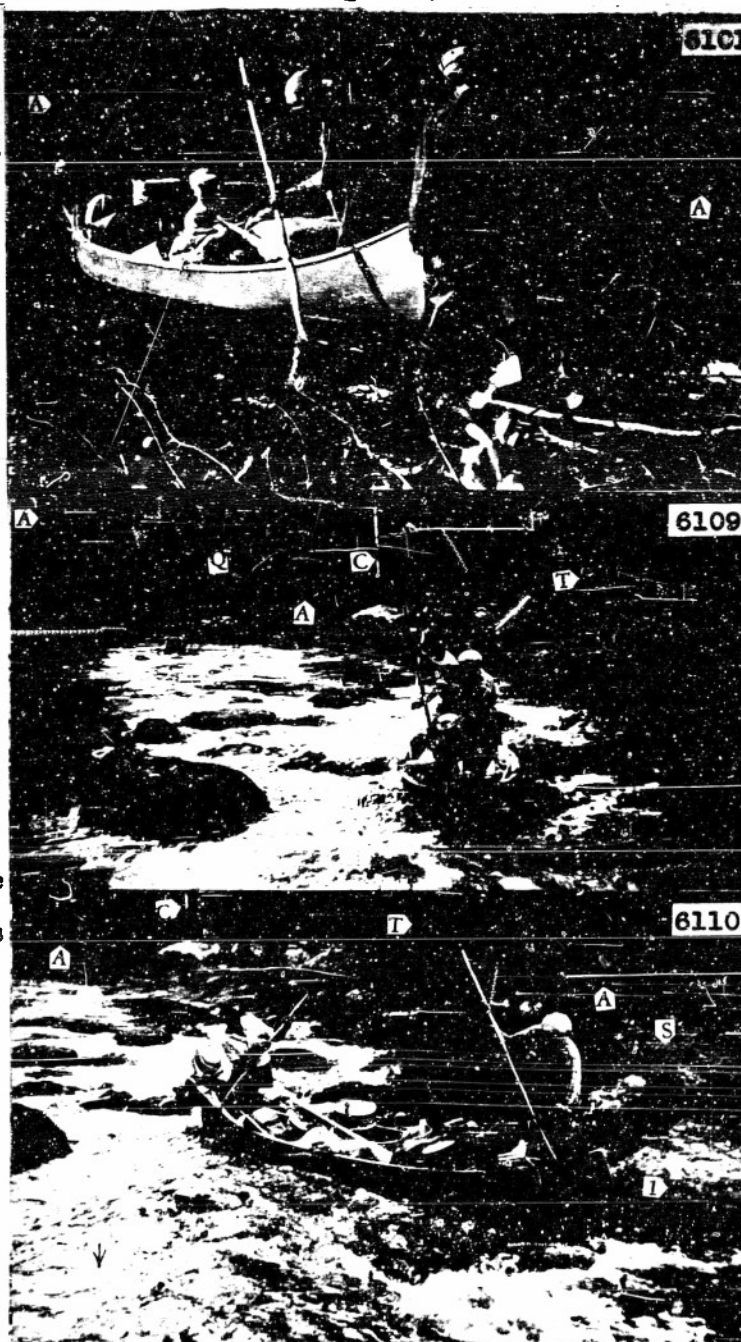
PLATE XIX

SECURITY INFORMATION

Ground Panchromatic Photographs Showing Methods of Canoeing
Utilizing Water from Beavers' Dam. Aug. 26, 1952.

(Cont. from Plate XVIII). In the case figured here, the rush of water carried the canoe in few minutes over a long hard portage, a divide about a mile long. Note that long poles and not paddles are used, the rear pole for steering, the front pole to serve as a brake. Such beaver's dam can be recognized on air photographs and incorporated in a proposed route. They are rather common in this area. In this particular trip, four such dams were utilized. This procedure is not really an outrage to Maitre Castor. It often freshens his environment and prevents the spread of his parasites. Usually in a few hours, the proverbially industrious beaver has restored his dam. Such divides usually sustain a dense population of black flies and mosquitoes without the slightest trace of table-manners to go with a voracious, ferocious appetite. Perhaps it should be pointed out that beaver's dams, even when large enough, are not suitable as landing places for hydroplanes. The water is too shallow; the bottom too muddy. Limbs or logs of very light barked aspen or cottonwood gnawed in very irregular lengths, floating in the beaver's dam help in its identification on air photographs.

In areas where it is difficult to "live off the land", planning a route for reconnaissance so as to pass such dams, makes available a small supply of emergency meat. (Beavers weigh 40 to 80 lbs).
(A) is alder; (C) cottonwood; (L) larch; (Q) quaking asp; (S) willow;
(T) cedar; (I) clay.



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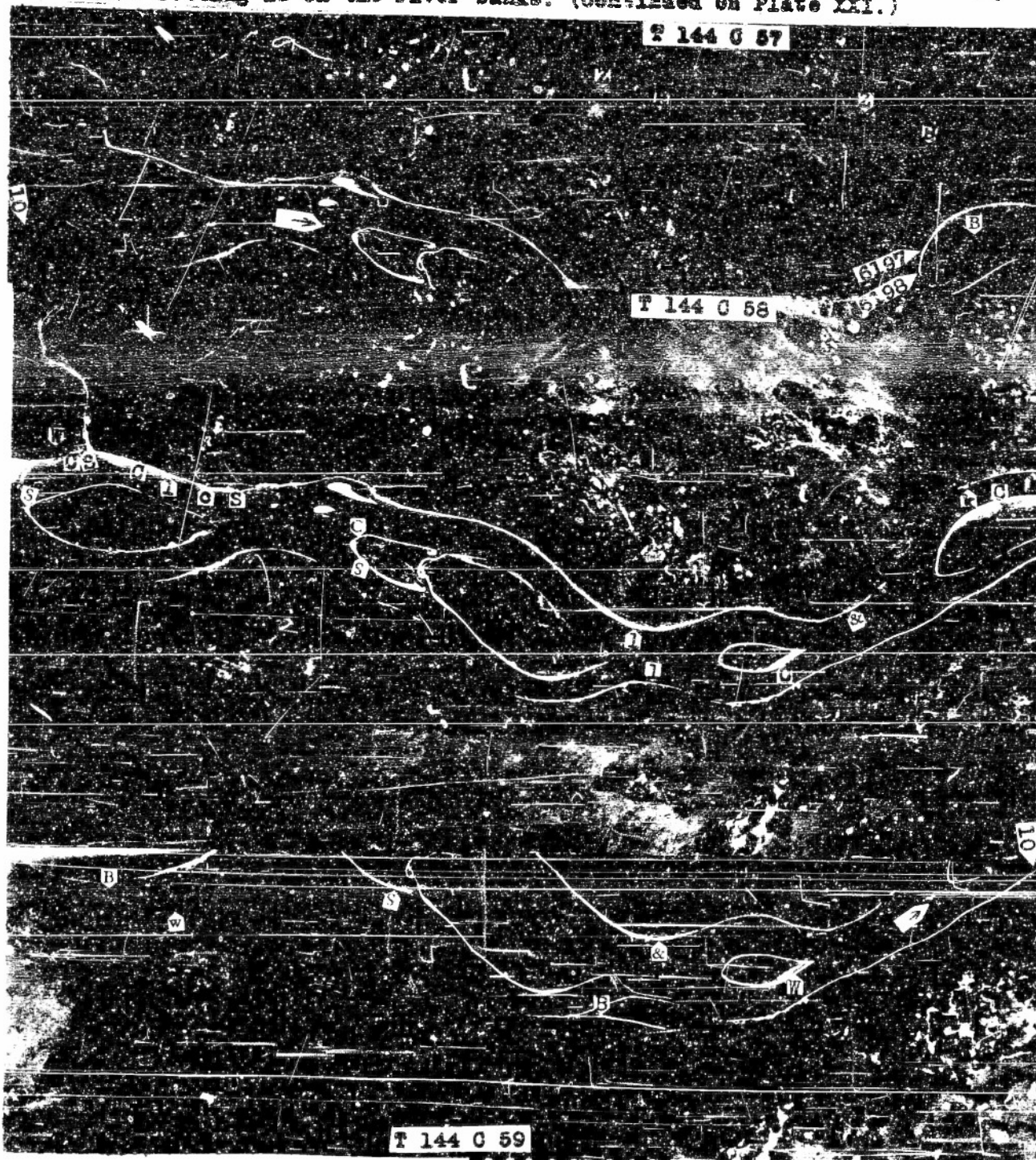
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**T. REF. SIX
PART. III**

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PLATE XX

Attawapiskat River at 52°50' W. Stores Triplet Fenchromatic Vertical Air Photographs. Roy. Canad. Air Force T 144 G 57, 58, 59. Scale 1/40,000. In this area of impervious clay capped by a foot or two of peat, the only solid footing is on the river banks. (Continued on Plate XXI.)



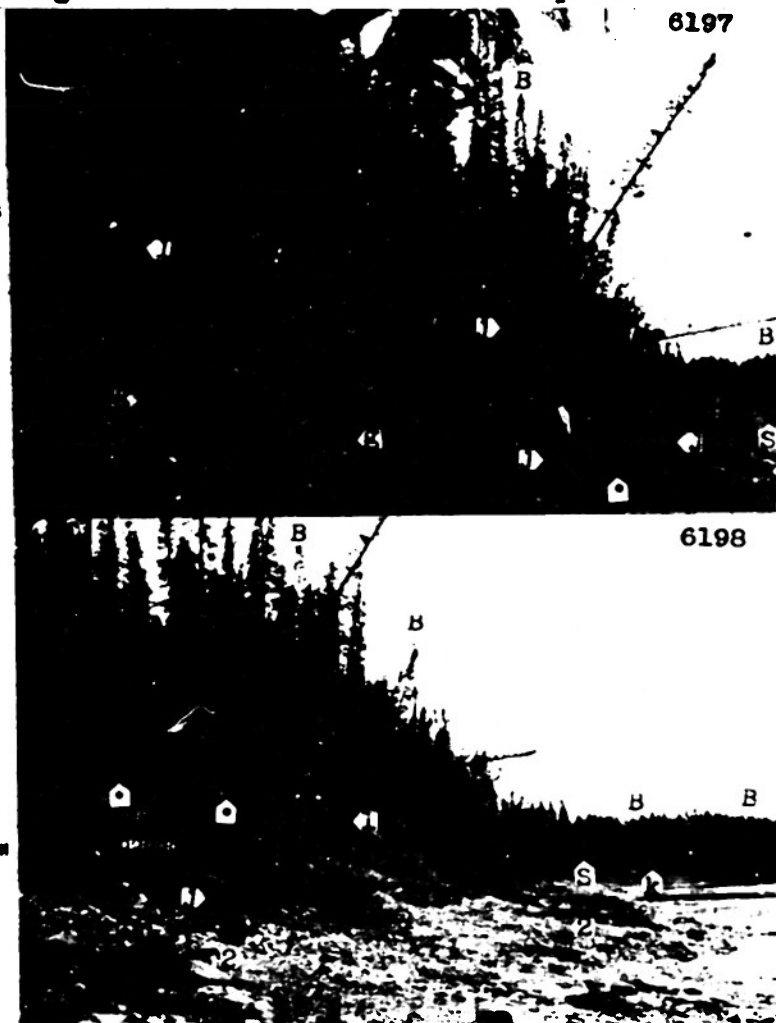
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Ground Panchromatic Photographs Showing Eroded Clay Banks of an Island in the Attawapiskat River at 82°50' W. Sept. 6, 1952. Gives details of Air Photographs of Plate XX and legend for that as well as this plate.

These panchromatic photographs of the island shown on air photographs on Plate XX, taken without filter, show the twenty-foot high, eroded clay banks (1); limestone boulders and cobbles with some sand (2); stands of black spruce (B), the tree that makes up more than 90% of the forests of this area as well as of the large area of Quebec (Ungava) and Labrador. A few spruces, near relatives of this tree, form vast forests in the subarctic region around the entire globe. This island has a cap of moist, soft peat averaging about 18" thick. The impervious clay underneath, and above the dense shade of the spruces and the bushes, with the tenacious water-holding capacity of the peat itself all combine to make the surface a soft wet mat that "quakes" at every step. The poor trafficability corresponds to such a soft, wet soil and subsoil. The banks are overhanging and at their brinks readily give way and slide down under the weight of traveller. On this

Plate as well as Plate XX, the following applies: (C) is cottonwood; (H) moist heath, 75% Labrador tea; (Z) marsh; (S) willows; (g) grass (Calamagrostis canadensis, the commonest grass in subarctic America); (J) roots and stumps of washed out black spruce; (*) peat; (k) landslide of clay; (w) pools of water mostly left by spring floods; (o) sedge marsh; (1) clay bank; (2) limestone boulder; (&) south-facing bank which is soon dried by the summer sun after the spring floods and is considerably better for any kind of travel in summer than the north facing banks (10). The air photographs shown on Plate XX show that except for the banks and the woods on them, the rest of the area is mostly treeless bogs and marshes of the very poorest trafficability. Note that if island (6197) had a better-drained soil, some cottonwood and white spruce would indicate this even on air photographs.

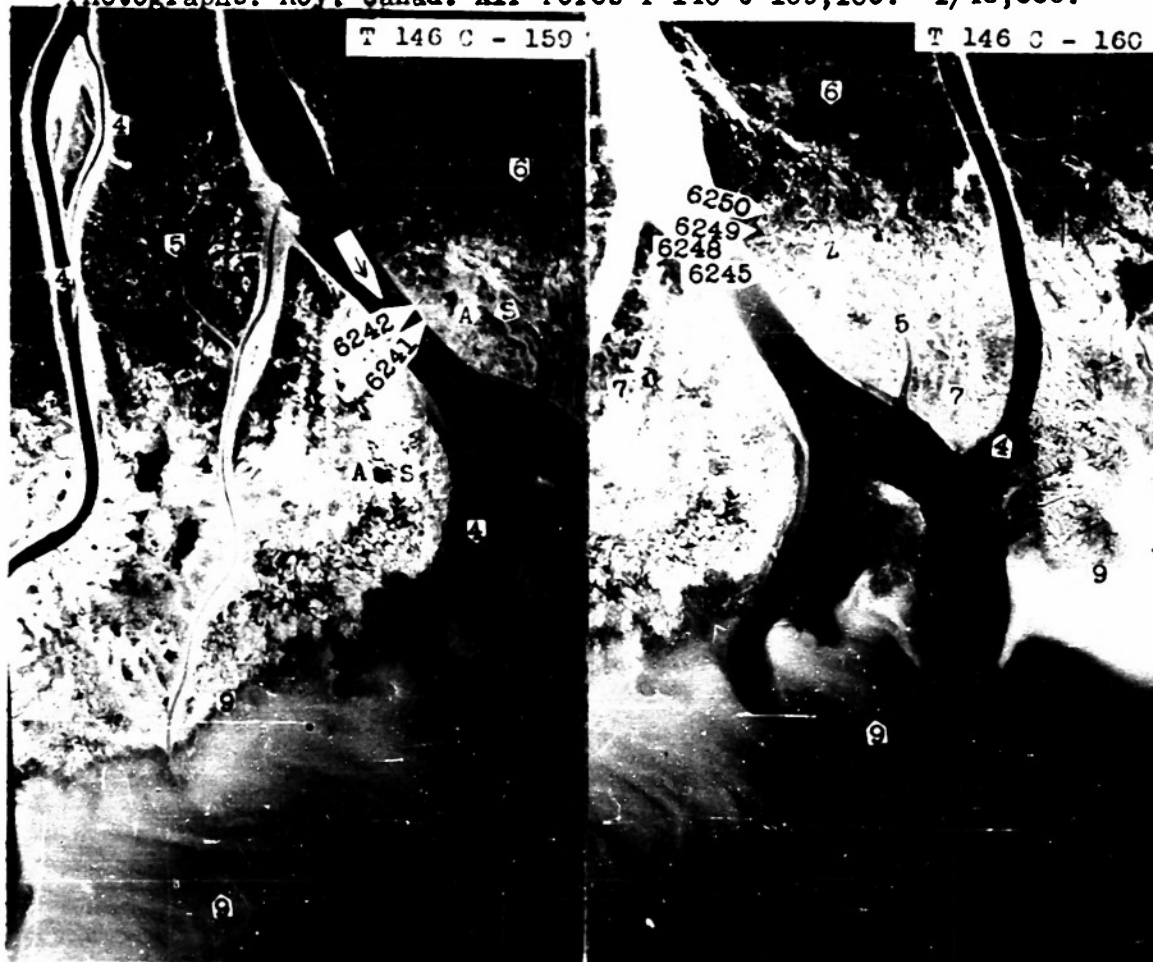


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PLATE XXII

Mouth of the Attawapiskat River. Stereo Panchromatic Vertical Air Photographs. Roy. Canad. Air Force T 146 C 159,160. 1/40,000.



The mud delta of the Attawapiskat River may be taken as a type of areas in the subarctic regions of the Old and New World where the rivers traverse large areas surfaced with a deep layer of clay. The very fine clay particles settling off the shore (9) settle slowly, are continually moved by longshore currents and cause the water to be constantly turbid. At very low tides the area (9) of such mud is virtually impenetrable. Such areas can be traversed on foot by threading one's way between pools and runnels and always stepping on the tufts or turf of grasses or sedges. Only tracked vehicles of the type of a weasel can traverse such an area at all times. In the winter when those marshes are frozen, they are readily crossed on snow-shoes. Tractors can readily move along the shores except where the ice has been piled up by the wind tide. The river itself with a 4-foot coat of ice is a highway. In summer logs are piled along the banks at low tide and floated down stream by the ensuing high tide. (4) indicates main channels; (5) small creeks or runnels; (6) pools with deep mud bottoms; (7) mud flats with little vegetation; (9) deep soft impossible mud when exposed at very low tide. (A) alder and (S) willow are bushes 5' to 6' tall, usually intermixed and forming margins or zones around pools.

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Ground Panchromatic Photographs of Tidal Marshes at the Mouth of the Attawapiskat River, Sept. 9, 1962. Shown on air photographs, Plate XXII.

On these tidal flats are innumerable bodies of shallow water of varying size from a mere puddle (6245) to small pools (6241 and 6249) an acre or two in size as well as very many channels or runnels. The pools very near the shore of James Bay have no bushes around them (Plate XXII-5). But the pools further inland can be recognized at a considerable distance by the border or zone of bushes, alders (darker-toned) and willows (lighter-toned, *Salix cordata*, with leaves whitish on the underside). This border of bushes can be seen on air photographs (6245, 6249 on Plate XXII) and quite easily on ground reconnaissance. These pools are commonly not much affected by daily tidal fluctuations but are flooded by exceptionally high tides. Such pools have mostly less than a foot of water but under the water a foot or two of soft mud. Any line of march to be traversed, whether on foot or on wheels avoids these pools or rather mud holes. Practically no sand and no peat but only clay (Plate XXII-7) makes up these deposits at the mouth of the river.

These tidal mud flats are very light-toned on air photographs (Plate XXII-7) when not overgrown by vegetation. In summer when covered by marsh plants, mostly sedges (here *Carex paleacea* Wahlenb. etc.) these flats are much darker-toned in summer than the bare mud. 6241 shows a sedge-grass-rush marsh. 6245 and 6249 show alders (A), willows (S), as a zone in the background with grasses and sedges forming zones in foreground and water not over two feet deep, lower right of 6249.

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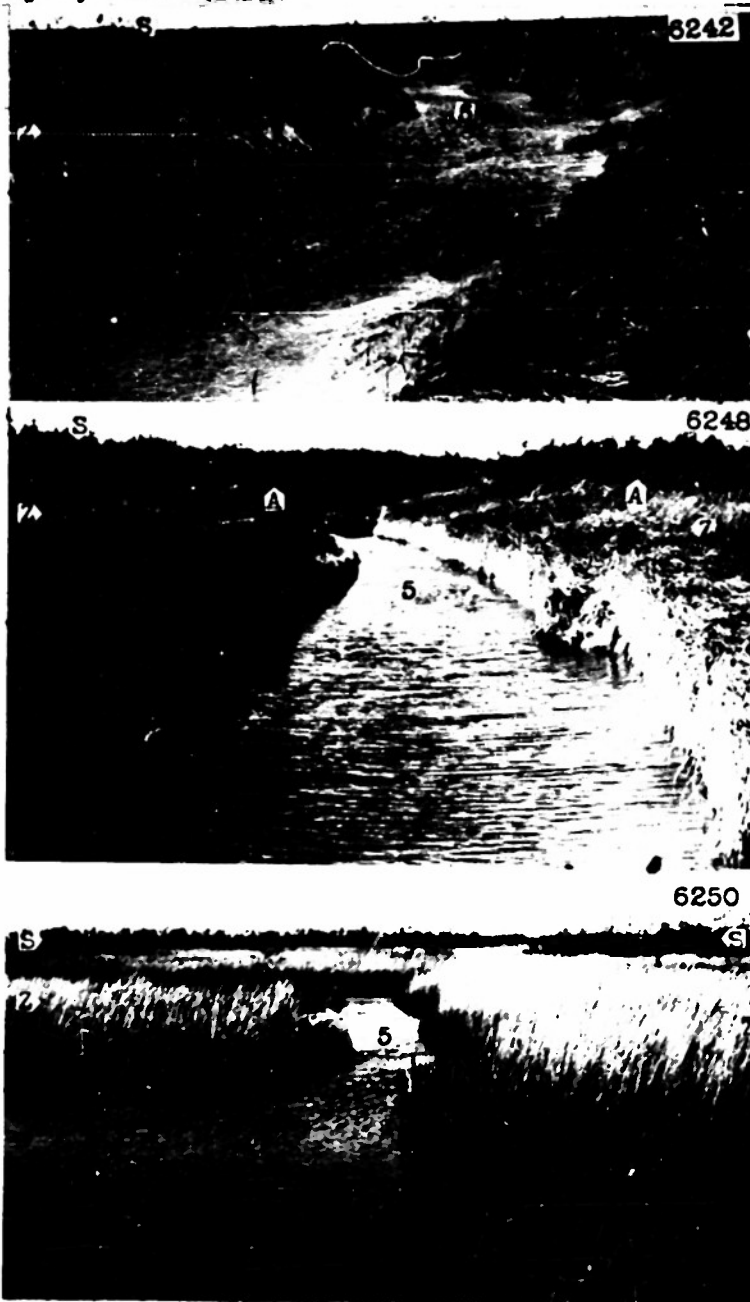
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Ground Panchromatic Photographs of Channels in Tidal Marshes at the Mouth of the Attawapiskat River, Sept. 9, 1952. Shown on air photographs, Plate XXII.

On Plate XXIV the very poor trafficability of these tidal marshes was described. The tidal flats covered by grasses and sedges (Z) afford better footing than the bare mud flats. The very many runnels or small creeks (6242, 6248, 6250) are always obstacles to travel overland. At average high tide, shown on these photographs, there is about 4' of water in these runnels but they are usually too very short in length as to offer little advantage for boat travel. At low tide when the water has run out, these creeks are very soft mud, a foot or two deep. The hedge or zone of bushes, alders (A), and willows (S), (6249 on Plate XXIII) indicate only slightly drier ground but with the disadvantage of the obstructive bushes in addition to the soft mud underneath, somewhat firmed by the roots of the bushes. The runnels do have one use. During periods of strong winds, which here affect the level of the water more than the tide, such small creeks are safe harbors for small boats. Driftwood is very scarce in this delta so that fuel is very difficult to find.

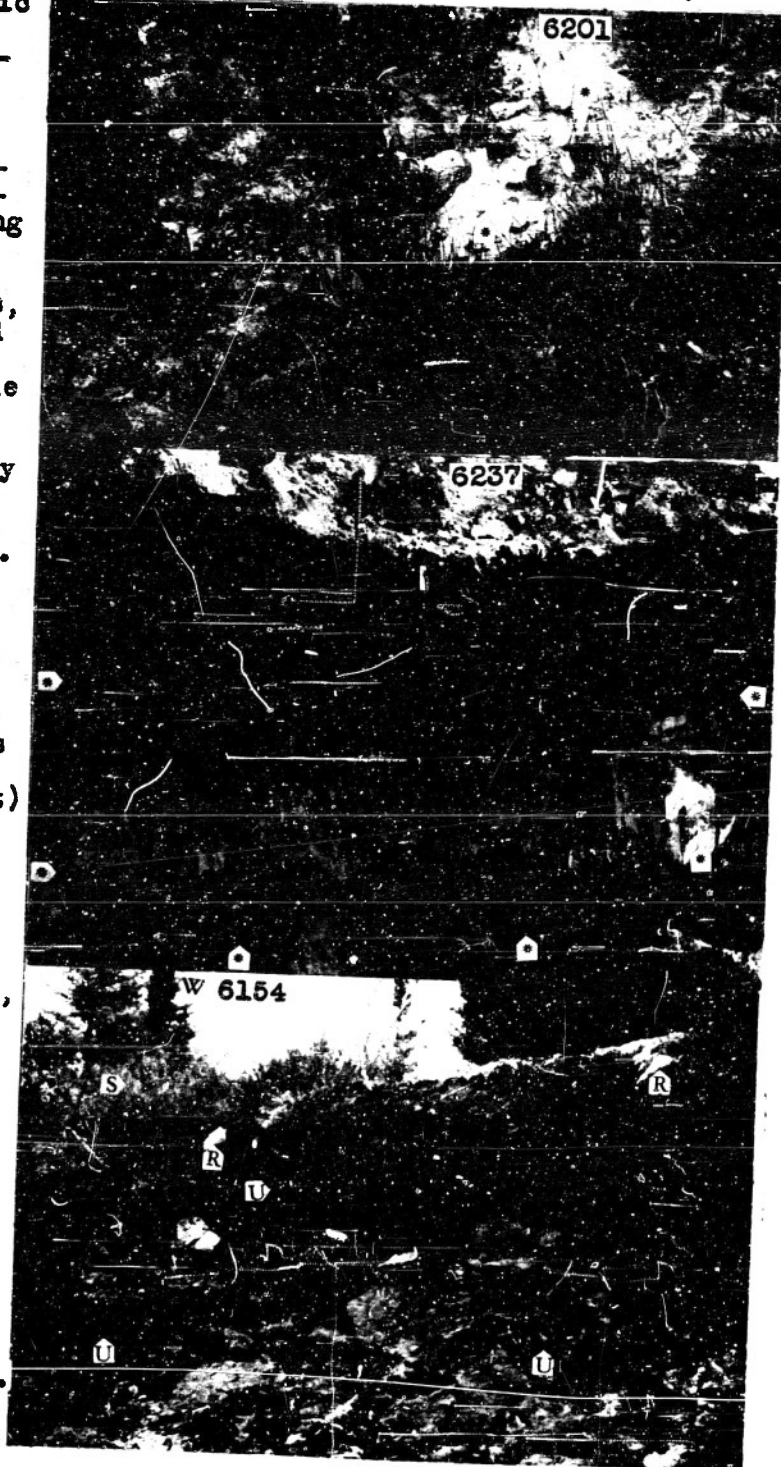
The practical way of crossing such an area as this, is by boat in the main channels at high tide. Even the main channels vary from year to year as the rivers deposit mud bars here and there.

(5) indicates the runnels or small creeks also shown on the air photographs on Plate XXII.



A Thick Layer of Clay at the Earth's Surface in the Flat Subarctic Region Means MUD, Deep, Devilish MUD throughout the Summer, a Formidable Obstacle to ALL Travel by Land But a Powerful Stimulant to Vigorous Vocabulary.

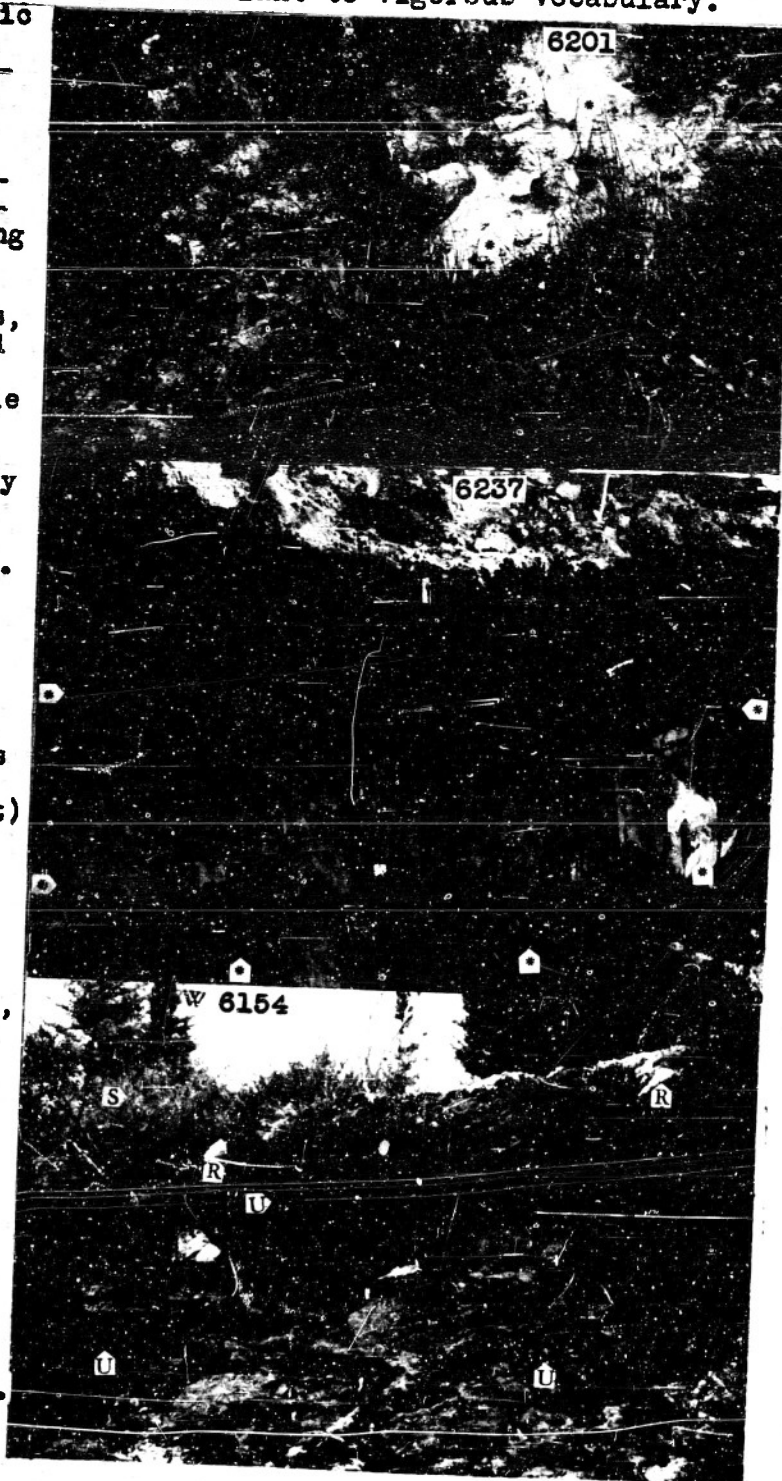
Very large areas in the subarctic and arctic regions in the Old World, in Alaska and in this Albany-Attawapiskat Area become a sea practically impassible mud throughout the summer. Military movement is greatly impeded; intrenchment practically impossible; road-making material wanting except for the logs that may be obtained from the bordering forests, for making corduroy roads, when the mud is not too deep and the supply of logs sufficient. Such "mud-areas" are recognizable on even small-scale air photographs, e.g. (2) on Plates I, IV, V, XII, XIV, XX, XXII, since they are tree-less and lighter-toned than the other types of vegetation in the vicinity. 6201 (Sept. 5, 1952, one-half mile up-river from Attawapiskat) shows a laced boot that has sunk to the depth of 9". The wearer could hardly extricate himself from the tenacious grip of the mud which would certainly have retained his boot had it not been laced. 6237 (Sept. 9, 1952, Attawapiskat) shows a cross-section of a ditch in which a few weeks before this picture was taken, three Indians were buried alive by the treacherous soft clay sides that gave way. Since the clay freezes to a depth of 4 to 12 feet in winter, the drain tile was set at a depth of 17 feet. The clay of this area is recently deposited and scarcely at all consolidated so that the spring floods readily undercut the river banks. (6154, Sept. 2, 1952. Banks of the Attawapiskat River) making it unsafe to walk on the edge of such banks. Flat slabs of compacted dead peat moss have sloughed of the bank. (R) is reindeer moss; (S) willow bushes; (W) white spruce; (*) clay; (U) dead peat moss. "In Poland, I learned of a fifth element-mud". Napoleon.



A Thick Layer of Clay at the Earth's Surface in the Flat Subarctic Region Means MUD, Deep, Devilish MUD throughout the Summer, a Formidable Obstacle to ALL Travel by Land But a Powerful Stimulant to Vigorous Vocabulary.

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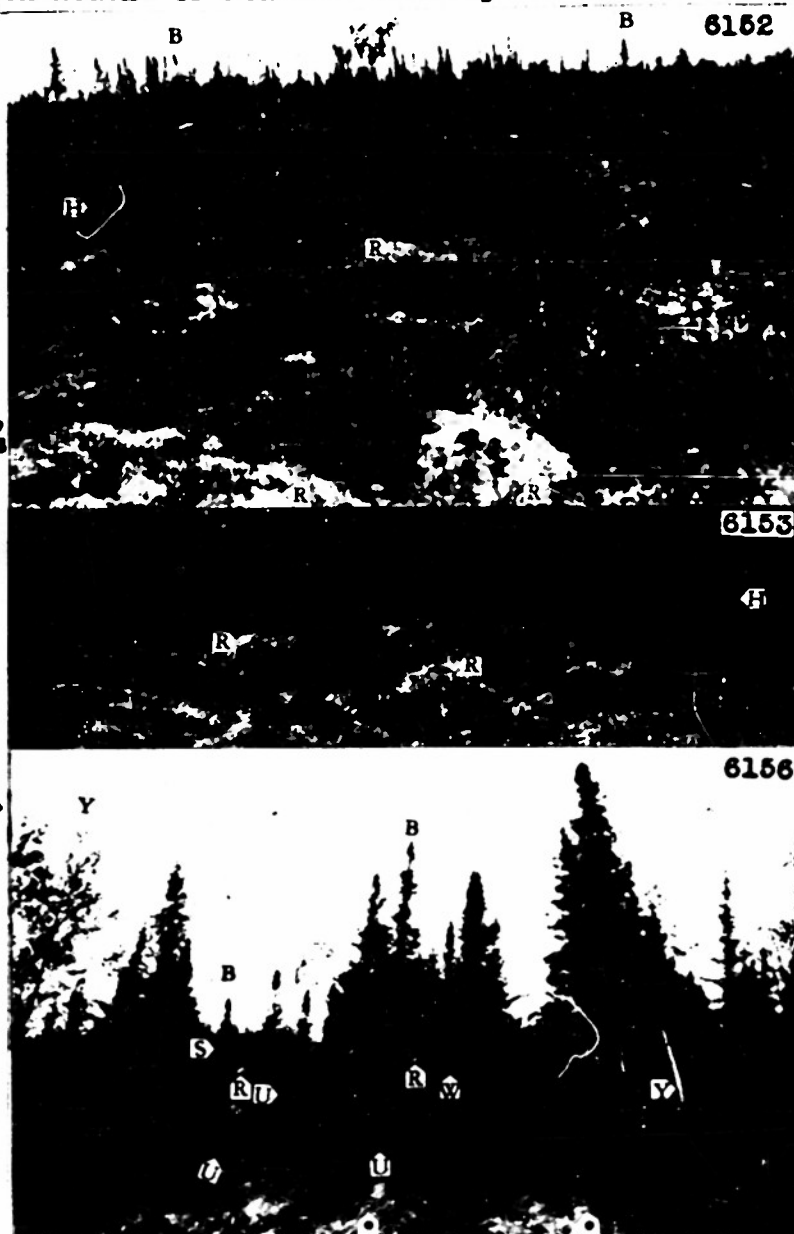
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A Layer of Peat at the Earth's Surface in the Subarctic Region is Indicated by the Type of Vegetation, Often Heaths or Heather. Attawapiskat Area.

In general, the heath in the subarctic region is a type of vegetation that indicates the presence underneath, of peat or dead peat moss (*Sphagnum*) in the early stages of peat formation. The plants of the heath family in the subarctic and arctic regions, are low shrubs or bushes, such as, blueberries. Many of these low bushes are evergreen with dark green leathery leaves, such as, Labrador Tea, (this bush makes up 75% of the bushes on 6152 and 6153) *Ledum greenlandicum* and *Ledum palustre*. On this account such areas appear a medium gray on air photographs (H on Plates XII and XX). The wet sedge marshes overlaying clay essentially without peat, show as much lighter in tone (Z on Plates I, IV, V, XII, XIV, XX, and XXII). Travel across such a heath is somewhat better than across the soft mud shown on Plate 25, no 6201, but is still very difficult, since the stratum underneath is soft and wet to a depth of about 12" to 18". Tracked vehicles can often cross such an area provided they are not driven in the same track more than once or twice. 6152, 6153, 6156 were all taken Sept. 2, 1952 on the banks of the Attawapiskat River above Sixty-mile

Rapids. 6156 shows the bank or cross section underlying the heath shown on 6152 and 6153. The ivory to cream colored reindeer moss (R) *Cladonia* species) forms white patches, commonly the higher percentage of this plant the less water-logged the area. Where the reindeer moss rests directly on the wet clay beneath, it slides along readily and causes the traveller to skid. (B) is black spruce; (H) heaths, mostly Labrador Tea, some arctic blueberry bushes, etc.; (S) willow bushes; (U) slabs of dead peat moss; (W) white spruce; (Y) white or canoe birch; (*) gray clay.



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C
Tech. Rep. 6
Part III

WHITE OBJECTS IN THE ARCTIC

WHICH ARE

NEITHER ICE NOR SNOW

Illustrated

by

Ground Photographs,

on

Plates XXVII to XXXIV

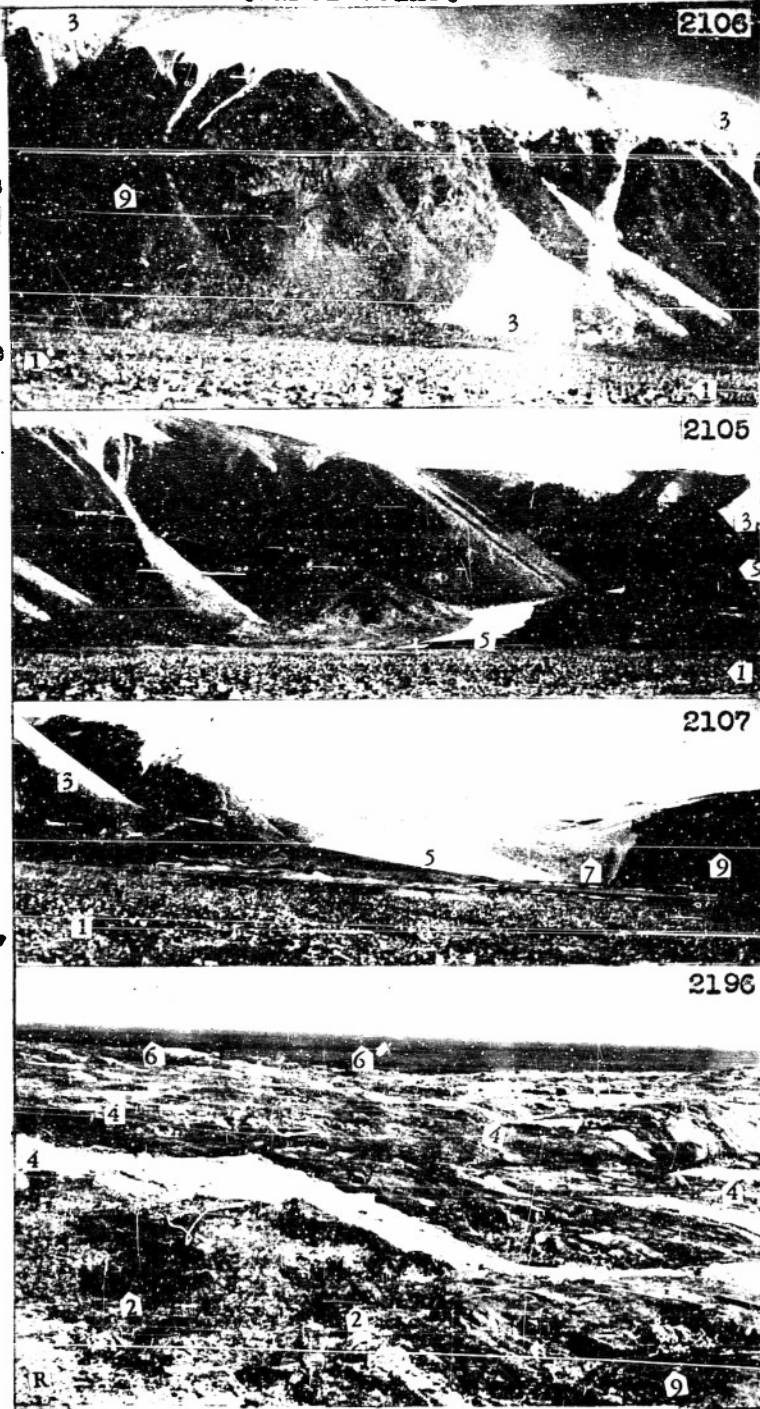
R E S T R I C T E D
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Which White Objects in the Arctic Are or Are Not Vegetation. Crystal-
line, Limestone, Glacier, Snow Bank and Quartz Veins.

ELLESMERE ISLAND

THE ARCTIC REGIONS

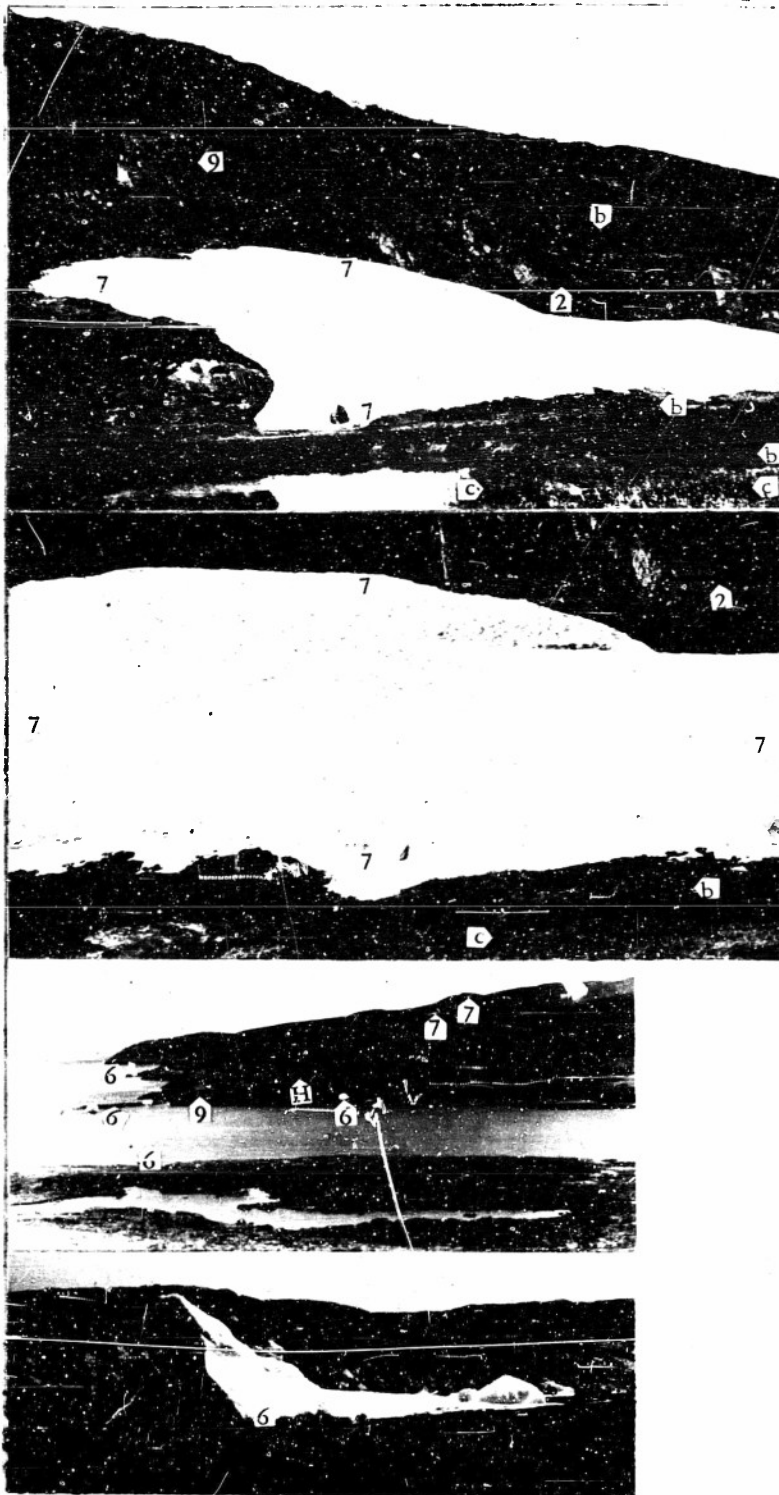
are commonly considered lands of snow and ice and all white objects, of unfamiliar shape, appearing on arctic photographs might be taken as snow or ice. While this is very largely true in winter photography, in summer, this assumption may lead to serious error as there are in the arctic and subarctic regions large areas covered with other white objects, such as, hundred and thousands of square miles showing white on summer photographs by reason of the white or very light colored reindeer-moss indicated as 1 in Rep. 5 (Pl. III, V, VII, VIIa, VIIla, IX, X, XII, XIII, XIV, XV, XVI, XVII, XVIII, XIX, XX, XXI, and (R) on this plate (2196), Pl. XXXII (6155) Pl. XXV, etc. Common white rocks, such as white limestone (3) or quartz (4) may be mistaken for ice (2106). 2105 however shows a glacier (5) which is, where it should be, in the valley, while the white limestone (3) forms the cap on top of the mountain, equally distinct in winter or summer. Quartz veins (4) appear as broad, white bands or dikes (2196). (1) is a gravelly deposit (moraine) of the glacier (5) which has retreated recently a half mile. The gravelly deposit is wet throughout the summer and has soft mud spots here and there. (2) Rock tripe "tripe de roche", a black lichen on rock; (6) ice-berg; (7) late snow, grey from accumulated dust; (8) granite. 2106, 2105, 2107 Craig Harbour, Ellesmere Island, 76° 20' N, 81° 30' W, Sept. 6, 1936. Photographed by Artheme Dutilly. 2196, Clark Harbour, Labrador, 60° 14' N, 64° 22' W, August 1939. Photographed by Gerard Gardner.



COAST OF LABRADOR

Which White Objects in Photographs of the Arctic and Subarctic Regions Are and Which Are Not Vegetation? Late Snow-bank and Grounded Icebergs.

Snow is not always white but may appear uniformly gray as on Plate XXVII (2107) on account of the accumulated dust or streaked from irregular melting. (6) Icebergs when grounded, a very common sight in the coves along the coast of Labrador, appear uniformly white on air photographs. At the foot of the snow (7) bank shown on the upper two photographs (taken by M. Duman, Aug. 1939, at Hopedale, Labrador), the writer observed a large patch of small birch bushes. (b). Those nearest the melting snow had not yet opened their buds; those further away, had opened only the flowering buds (catkins), but had no leaves and those still further away had fully formed leaves. This shows the size of the large snow drifts which form on this wind-swept coast, and how the vegetation records them. Soft spots are very rare on this rocky coast. The principal hindrances to travel are the steep slopes, the boulders and the rock crevices. Note the absence of trees and the truly arctic appearance of the vegetation so far south of the Arctic Circle. When the sun shines on such a grounded iceberg, it may, on rare occasions, "explode" with sound of machine-gun fire, as the writer observed at Chateau Bay in the Strait of Belle Isle, July 1939. (2) black lichen; (9) granite; (H) heath; (c) sedge marsh.

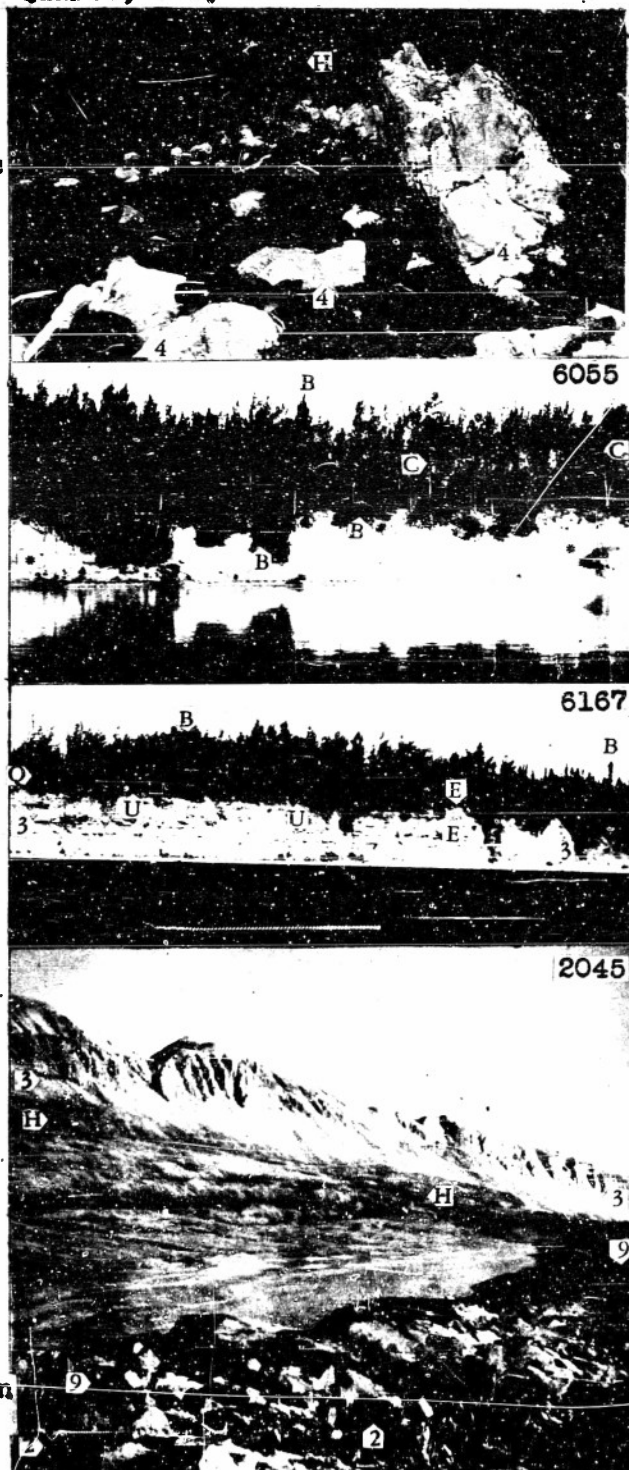


BAFFIN ISLAND

SECURITY INFORMATION

Which White Objects on Photographs of the Arctic and Subarctic Regions Are and Which Are Not Vegetation? Quartz, Clay and Limestone.

Quartz resists weathering longer than any other common mineral, so it is not surprising to find large masses of it as shown in the upper photograph taken at the head of the fiord of Wakeham Bay, Hudson Straits (Aug. 1939. M. Duman). At a distance of a mile, this appeared to the author as the ruins of a marble city. Such glistening masses of quartz appear on air photographs as blocks of ice or masses of late snow. Light gray clay may appear practically white on photographs as shown on 6055, on the bank of the Albany River, Aug. 16, 1952. Evidently by its position this could not be a bank of snow. The similarity of tone between this clay bank and that of the ivory white limestone on the bank of the Attawapiskat River, Sept. 3, 1952 as shown in 6167, is noteworthy. On the other hand, a white limestone may appear gray when photographed while the sun is in such a position as to cause numerous small shadows as shown on (2045) taken at Arctic Bay by Arthème Dutilly, Sept. 8, 1936. This photograph shows the very low bushes (heaths), grasses and sedges that make up the sparse, scant vegetation less than 6" high in the "high arctic". Travel over such vegetation is not at all difficult; walking on the spongy turf, very easy. In contrast the top photograph shows the "low arctic" with the vegetation (heaths, etc.) more than 12" high. 6055, 6167 show the tree-covered subarctic. Thus this Plate shows the contrast of vegetation of the arctic and subarctic. Appearing very nearly white is the silver leaf bush (E). (B) Black spruce; (C) cottonwood; (H) heath; (Q) quaking asp; (U) peat; (2) rock tripe; (4) quartz; (9) granite. Arctic Bay is on Baffin Island at 73° N, 74° W.

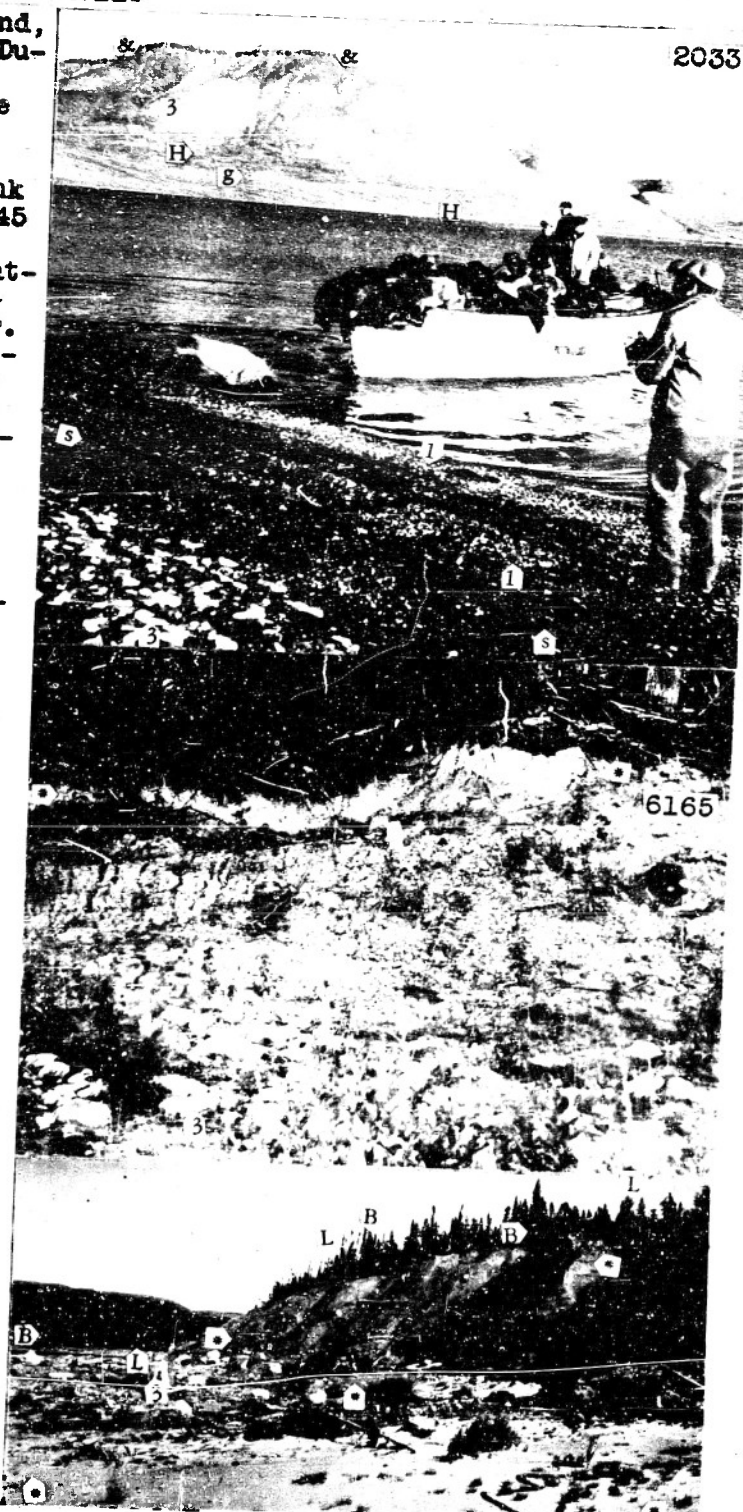


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Which White Objects on Photographs of the Arctic and Subarctic Regions
Are or Are Not Vegetation? Shells

2033. Arctic Bay, Baffin Island, 73° N, 84° W, Sept. 8, 1936 (Dutilly). 6165. Gray clay bank with white shells, bank of the Attawapiskat River, Sept. 3, 1952 (Duman). Lowest: Blocks of white limestone on clay bank of the Larch River, August 1945 (Dutilly).

The single photograph illustrates a number of important features for the photo-interpreter. Most remarkable is the encircling dark line like a fortification near the summit, appearing like a line of alders growing on a seepage of a perched water-table. It is a layer of crystalline rock (cyanite) and is an excellent landmark for navigators of ships or planes. On the same picture is seen another white object, an eskimo dog. In the eastern Canadian Arctic, they are nearly always ivory white or black or both. Even at midday in the Arctic shadows are very long, here twice the height of the man. All three photographs show small white objects, pieces of white limestone and shells, the latter small, not exceeding an inch. The beach on 2033 provides excellent firm footing around the entire bay; the river banks facing south affords less easy travel while the banks of the Larch River is full of scattered spots of soft, treacherous mud. Note that the vegetation on the south-facing slopes like the hill on 2033 have considerable more vegetation than those facing north, commonly low heaths (H) and grass-like plants, (g). Sand (s) and gravel (l) which make up the excellent beach at Arctic Bay are entirely lacking in the other two localities, pieces of limestone (3) being the only element common to all three. (&) cyanite; (*) clay; (B) black spruce; (L) larch.



SECURITY INFORMATION

Which White Objects on Photographs of the Arctic and Subarctic Regions
Are or Are Not Vegetation? Fog, Low Cloud, Smoke from Burning Coal.

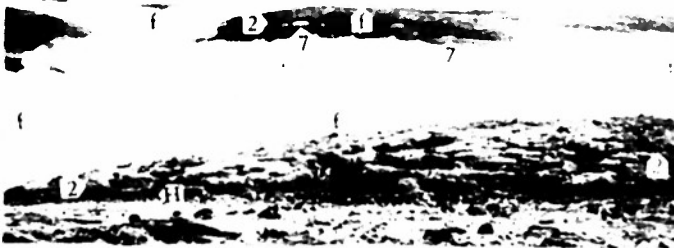
Arctic Bay, Baffin Island, Sept. 2020
9. 1936. 73° N, 84° W. 2020.

Cape Wolstenholme, Hudson Bay,
Aug. 23, 1936. 2910 Smoky
Mountain, the Arctic Ocean East
of the Mackenzie Delta, 1934.
Waterfall on the Wiachowan River,
Richmond Gulf, Hudson Bay, July
22, 1945. All photographs by
Arthème Dutilly.

The condensation of water vapor
in winter or summer may form areas
of white or very light gray on an
air or ground photograph. These
may be low clouds, mist, fog (f),
smoke from burning coal, spray
from a water-fall, the breath of
man or animal, etc. On 2020 is
seen a hanging fog coming from a
neighboring fiord of Admiralty
Inlet. By contrast with its dead
white, the appearing nearly white
to the observer on foot, limestone
(3) (see the same limestone on
Pl. XXIX, 2045) appears decidedly
grayer. Note that the limestone
(3) in the deep shadow appears
lighter than the granite (2) and
that the white dots on the left
are the white-painted Hudson Bay
Company's Trading Posts. The dark
foreground is a rather dense low
growth of heaths (H) about 6" high
with some lighter-toned tufts of
grass (g) growing on a few inches
of "soil", easily traversed on
foot. On 2910 is seen a cloud
1300 feet thick the common oc-
cupant during the summer of this
cove with nearly perpendicular
walls of the same height. By
walking toward the sound of the
rushing of the torrent, it is
possible to find a break in the
cliffs, where the ascent is not
too difficult on foot. Some late
snow (7) still lies on the very
scant vegetation on the nearly
bare granite. On 2604 the coal
(burning for generations) has
burnt the clay to many shades of
red to buff, brick-like debris
at the foot of the cliff. The
mass of smoke at times causes
total lack of local visibility
for flying.



2910



2604

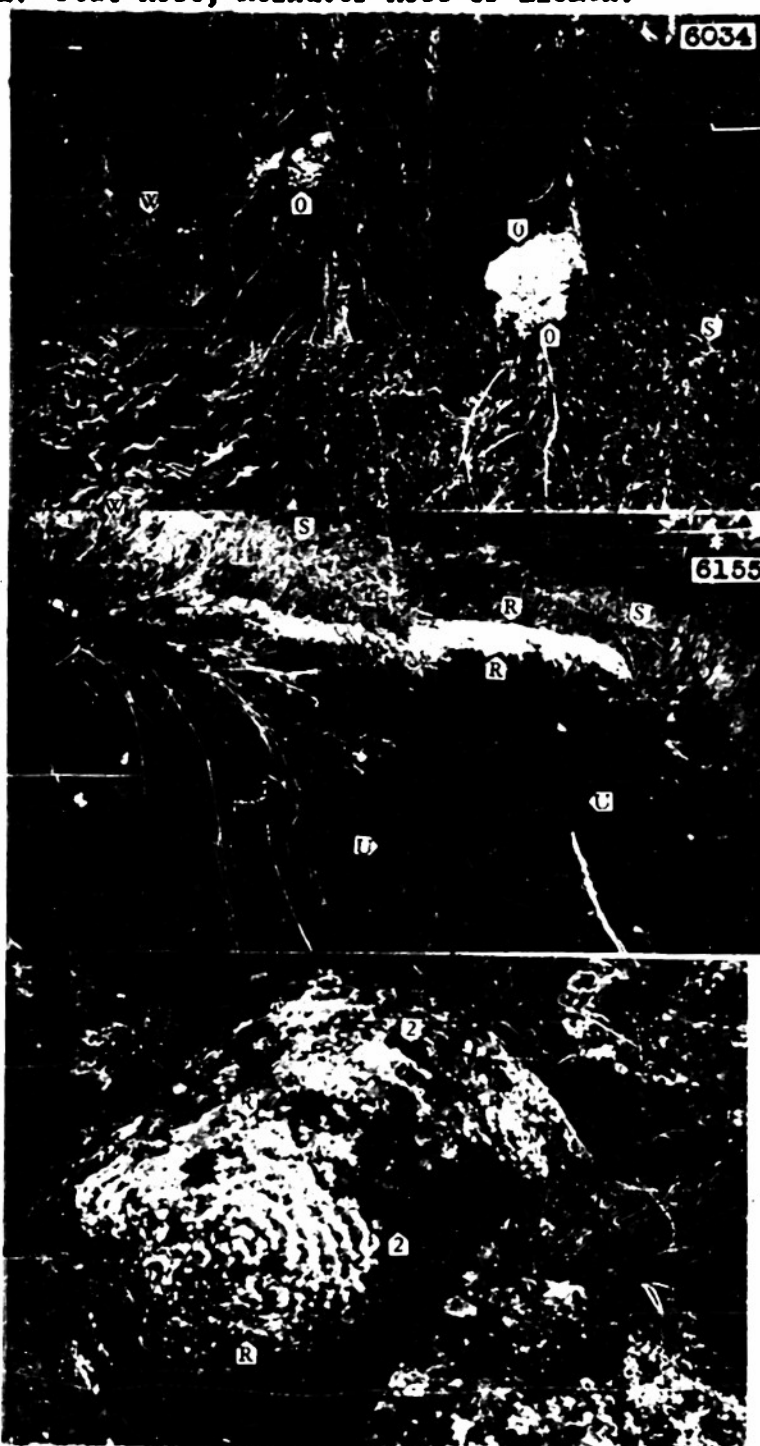


Which White Objects on Photographs of the Arotio and Subarotio Regions -
Are or Are Not Vegetation? Peat Moss, Reindeer Moss or Lichen.

Fungus-like mosses of white, the size of a head, on the branches of trees and shrubs near an Indian settlement are peat moss being dried preliminary to use as the most efficient and inexpensive diaper service in the world. To the eye, the moss appears pale grayish green although showing nearly white on photographs. (6034. Along the Albany River, Aug. 16, 1952. Duman).

The many kinds of reindeer mosses all showing conspicuously white and very much alike on ground and on air photographs cover large areas in the open spruce forests. Above the tree line and above the shrub or "bush line", this white vegetation covers enormous areas except on the wettest, marshy terrain, e.g. the plateau of Labrador and Ungava, above the black spruce and alder vegetation is very largely this reindeer moss (i.e. lichens).

(See text on Plate XXVII to find many views of this vegetation in Tech. Rep. No. 5). Smaller masses of reindeer moss and other pale lichens often assume puzzling patterns sometimes like patches of snow (6155, along the Attawapiskat River, Sept. 2, 1952. Duman), or concentric rings as in the last photograph, a vertical view, Sleeper Islands, Hudson Bay, Sept. 1939. Duman. (2) Rock tripe; (O) Sphagnum; (R) Reindeer moss; (S) Willow; (U) Humus; (W) White spruce. Some arotio lichens form large patches of bright orange but appear nearly white on photographs.



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Which White Objects on Photographs of the Arctic and Subarctic Regions Are or Are Not Vegetation? Leaves, Flowers, Straw and Snow.

A marsh of grasses or sedges with leaves fresh and green (c, 34) or bleached to a straw color when dead or dying (c, 7100) may appear white or very light gray on panchromatic prints, especially when taken with a deep yellow (e.g. Wratten G) filter. When the scale of the photograph is not too small, the difference in texture may be sufficient for distinguishing snow from sedges. On # 3 is shown the white flowers of Labrador Tea (K), a very common evergreen bushy heath in much of the American Subarctic from Labrador to much of Alaska. Newly fallen snow (as in 7100) may resemble reindeer moss which, however, does not grow to the edge of the water, a distinction useful in white masses on even small scale photography. Straw-colored clusters of squirrel-tail barley (g) as well as rose-purple flowers of fireweed (F), both extremely common weeds on the well-drained shoulders of the Alaskan highways, often show nearly pure white on photographs. The dark depressions on 34 are the tracks of a caterpillar tractor. Since there were no white "heads" of cotton-grass showing anywhere on long stretches of these tracks, the presumption is high that they are less than 2 years old. (see also Pl. XXXIV).

34 & 3 near Slana, Alaska, June 27, 1947. A. Dutilly. On 34, numerous sounding showed the ground was permanently frozen at a depth of 12" to 18". 7100. Beacon Island, Mouth of Ft. George River. End of September, 1939, M. Duman.

N-O Roadside near Nabesna, Alaska. H. Ball and O'Neill. July 1947.

7 - snow; B - Black spruce; W - white spruce (injured by fire); S - willows. On # 7100 is shown a rock pool where water from melting snow and rain as collected in a basin of granite. Such pools are very common in the glacially-eroded regions. The low "tundra" growth is characteristic of all the islands in Hudson and James Bay.



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PLATE XXXIV

SECURITY INFORMATION Recognition of Cotton-grass
Useful in Photo-intelligence

Which White Objects on Photographs of the Arctic and Subarctic Regions
Are or Are Not Vegetation? Cotton-grass.

Cotton-grass (several kinds of it) like nearly all sedges are grass-like plants very common in bogs or in places where the native vegetation has been disturbed. This can be seen in and near the tractor tracks on 31 as numerous white dots, the "cottony" heads. The same kind of cotton-grass (*Eriophorum Scheuchzeri* Hopps) can be seen in the boggy rim of a rock pool (7000). Parallel white lines especially on a black peaty soil and therefore of very high contrast, on even small-scale air photographs taken in summer (July-Sept.,) are commonly white heads of cotton-grass that have invaded the tracks left by a tractor two to several years before the photograph was taken. Tractors in many parts of the Arctic indicate military activity within that period of time and hence the habits and occurrence of this plant are worthy of study from the standpoint of military intelligence. In mosquito control, such lines of cotton grass can be safely taken as potential mosquito breeding grounds. Numerous soundings at 31, showed frozen ground at depths of 12" to 24". No. 6 shows 2 other kinds of cotton-grass in a newly made road-side ditch where they are sometimes so abundant as to make such roads on air photographs very much more conspicuous. On No. 7000 the dark line of vegetation indicates the height of the water from the melting snow in spring, (-). Note that the lines made by the jointing of the granite are darker than the scratch-lines made in the processing of the film and are not parallel to the edge of the print. (B) is black spruce; (C) cottonwood; (W) white spruce; (2) marsh; (c) sedges; (9) granite. 31. Glenn Highway, Alaska. July 1947. A. Dutilly. 6. Road-side near Anchorage, Alaska. H.C'Neill, July 1947. 7000, Gilmore Island, Ottawa Islands, Hudson Bay. Sept. 1939. M. Duman.



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Tech. Rep. 6
Part III

LANDING CONDITIONS

ON

ARCTIC BEACHES

AND

DARK OBJECTS.

Illustrated

by

Air and Ground Photographs

on

Plates XXXV to XLV.

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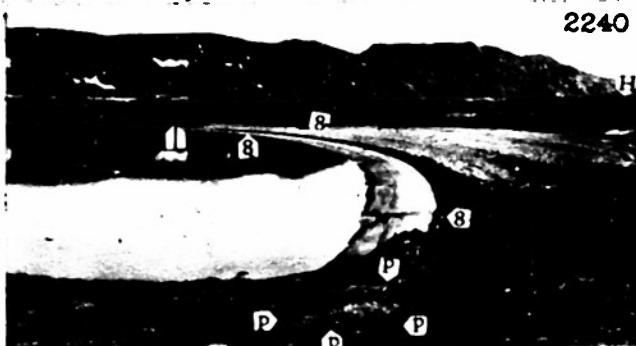
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PLATE XXXV

Recognition of Types of Arctic Beaches on Photographs.

Which Dark Objects on Photographs of the Arctic and Subarctic Coasts Are or Are Not Vegetation? Dead Seaweed, Live Seaweed and Heaths.

Black lines parallel to the beach are commonly rows of dead seaweed which mark the level of the average high tide (8). Raised black lines, irregularly paralleling the shore and above the level of even the highest storm tides are heaths, low evergreen bushes (H), often following the contour of old, raised beaches. If the tide happens to be out, the distance between the seawide line and the water line is the beach, of firm, hard sand. Such one or few regular flat black lines parallel to the shore indicate a fine, firm, hard beach. 2240 shows a raised beach a very common sight on the Labrador Coast. Coves on this coast are frequently iceberg graveyards which in melting may deposit boulders of great size. Since such are not charted they are a hazard to small boats approaching the shore, and at high tide are difficult to distinguish (when covered by seaweed) from the bridge or from an air photograph. At low tide they are easily seen (2241). The "white" eskimo hut (/) is made of unpainted planks. On the hill overlooking are "polygons" (p) often of deep soft mud with some pebbles heaved to the surface by frost action. The somewhat irregular flat black line of dead seaweed on 2360 indicates a sandy and rocky beach intermediate between 2092 (Pl. XXXVI) and 2240. From the very slippery rocks of this beach, edible mussels are commonly gathered at low tide by the eskimos, as well as small fish in the pools. 2240, 2241, 2243 show Port Manvers, Labrador, Aug. 1939, G. Gardner. 2360 Pangnirtung, Baffin Island, 66°N 65°W, Sept. 9, 1936. Dutilly. (g) grass; (6) grounded iceberg.



2240



2241



2243



2360

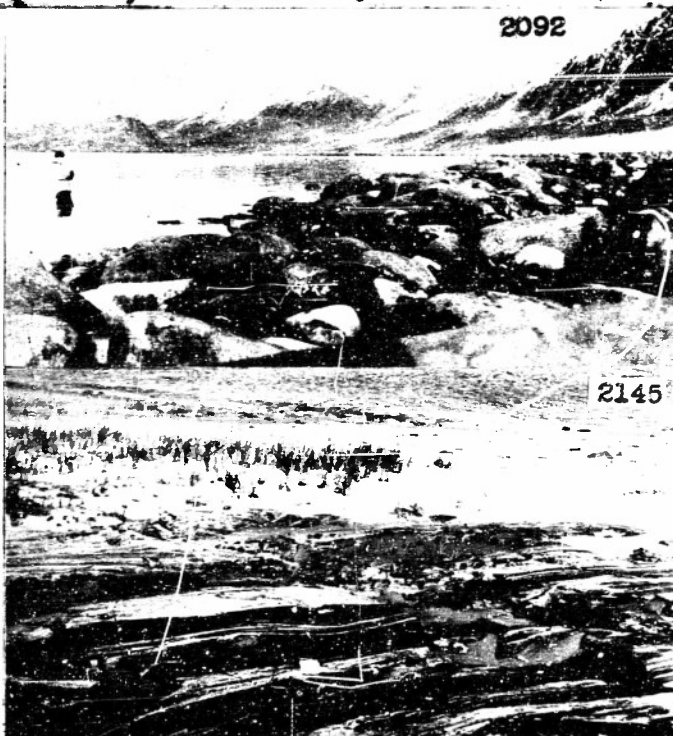
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Which Dark or Light Objects on Photographs of the Arctic and Subarctic Rocky Coasts Are or Are Not Vegetation? Live Seaweed, Sea Rye and White Sand, Blocks of Limestone and of Granite, Broken Off by Frost Action.

The first snow of the season shows as a white coat on the upper half of the mountain but not on lower half of the slope. This is because the snow does not melt readily on the bare rock and lichens but does melt on warmer lower half where the heaths and grasses grow. Live seaweed, as well as dead (Plate XXXV) appears dark on photographs. On even a small scale air photograph the irregular dark network-pattern, forming a wide belt between low and high level, indicates a rocky beach. On a sandy beach the black line of dead seaweed is above average high tide level in one or a few rows parallel to the beach, (2092, Pangnirtung, Baffin Island, 66° N 65° W, Sept. 22, 1936, Dutilly). Dry Sand, with or without a growth of sea rye appears nearly white on aerial photographs (2145, Beacon Island, Mouth of the Fort George River. Sept. 1939, G. Gardner). Frost action causes rapid breaking at the joints of rocks such as "stratified" granite (Fairway Island, 63° N, 90° W, Aug. 13, 1933, Dutilly, 2142); spalled off granite (Churchill, Aug. 6, 1936, Dutilly, 2075) or gray limestone contrasted with a patch of new snow. (2172).



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ART III

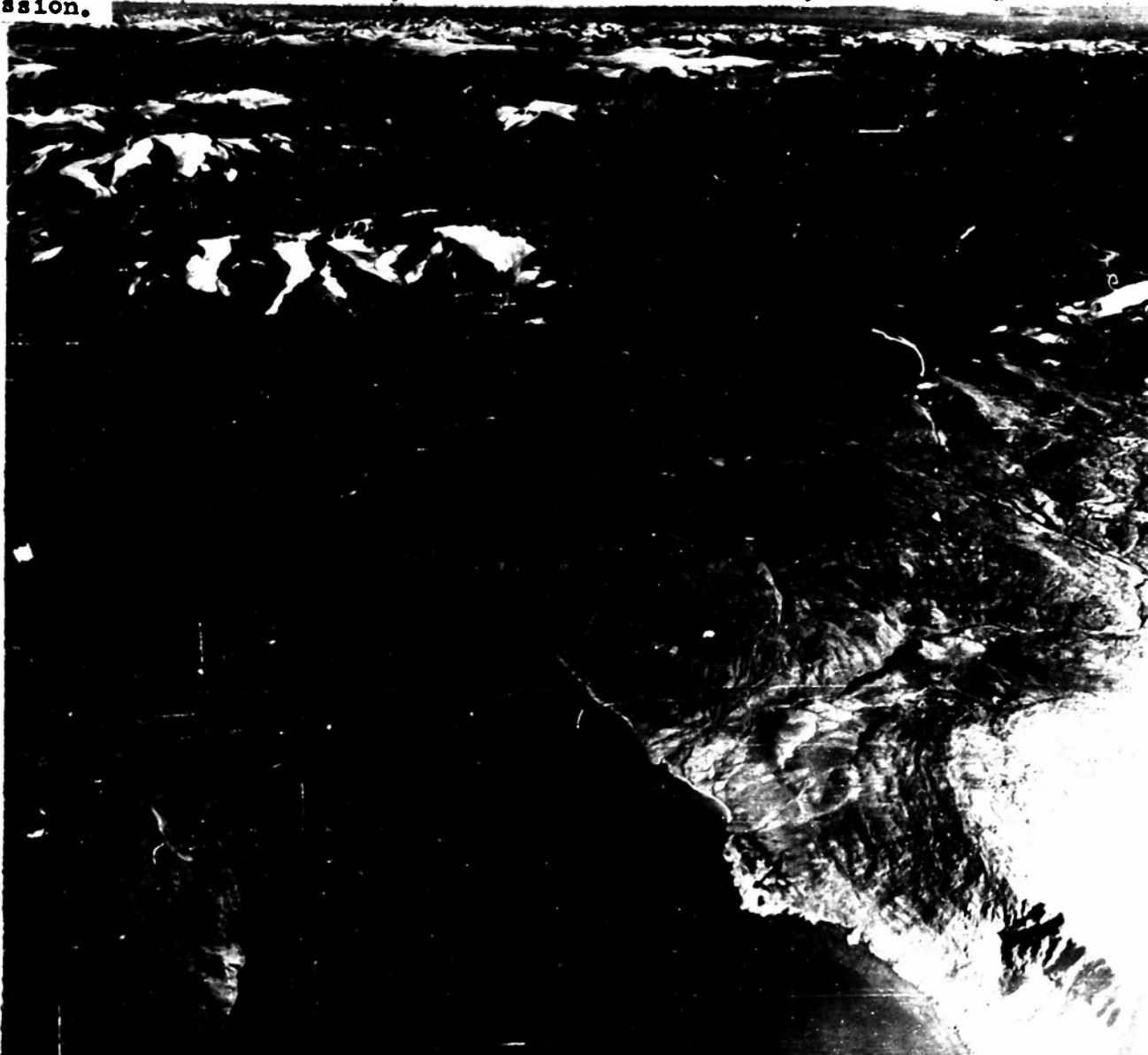
Arctic
Beaches

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PLATE XXXVII

Pangnirtung, Baffin Island, 66°N 65°W. A Panchromatic Oblique Air Photograph. Scale Smaller than 1/40,000 Roy. Canad. Air Force. T 352R-100 The beaches shown on Plates XXXV, 2360 and XXXVI, 2092 with the Posts of the Hudson's Bay Co. and the Royal Canadian Mounted Police, and the Anglican Mission.



KEEP WIDE MAF

Tides are high in the fiords, here as much as 15'. This air view shows the beach at high tide, while Pl. XXXV 2360 shows at middle tide and Pl. XXXVI 2092 shows at low tide, a beach stream with boulders and a dense growth of algae which is very gelatinous, very slippery underfoot especially to rubber soles. The eskimo sealskin boot "mukluk" gives a much surer footing than rubber. The size and abundance of the slippery boulders and the shiny seaweed are significant in landing operations. Further inland there is sandy-gravelly beach as indicated. While sea water in the fiord has a dense growth of very large, coarse seaweeds, the vegetation on the land is sparse. The pattern assumed by the dead seaweed on the strand indicates to some extent the type of beach and the level of the highest tides.

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PLATE XXXVIII

Igloolik, 69°22'N. 81°43'W., a Small Island, in Fury and Hecla Strait, the North Shore of Melville Peninsula. Panchromatic ~~Color~~ Air Photograph, Roy. Canad. Air Force, T 255C-20. The remarkable series of parallel wavy lines shows the successive increments added to this beach. (See below)



KEEP WIDE MARGIN

In 1811, according to Parry's map, there was a channel in the center of this island. Today the highest ridge of the beach is about 30' above sea level. The dark toned curving bands (H) are low bushes above 6" high, mostly heaths and indicate good travel conditions. Plate XXXVI 2172, shows the solid footing.

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PLATE XXXIX

SECURITY INFORMATION

Arctic Bay, Baffin Island, 73° 5' N, 84° W. Panchromatic Stereo Vertical Air Photographs, Roy. Canad. Air Force, A 13304-318, 319. Ground Photographs on Plates XXIX, 2045; XXX, 2033; XXXI, 2020 and located below.



&: outcrop of rock (cyanite). h:buildings. H:heath bushes 6" to 12" high. g: grass and sedge marsh, soft peat underneath. 8: large stone fragments spalled off by freezing. l:sandy beach. 2: granite. 3: limestone. 7: ice.

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SECURITY INFORMATION

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Beaches

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SECURITY INFORMATION

PLATE XL

Arctic Bay, Baffin Island, 73° 5'N, 84° W. Panchromatic Oblique Air Photograph, Roy. Canad. Air Force, T 249R-160. Showing the West Shore of Admiralty Inlet. Panoramic View of Area Shown on Plate XXXIX. Ground Photographs are on Plates XXIX, 2045; XXX, 2033; XXXI, 2020. Iceberg, Growlers.



This is probably the finest oblique air photograph the author has ever seen. It was taken a little later in the summer than the preceding, and like that picture shows the difference in temperature of the north-facing and the south-facing bay (Arctic Bay). While the latter is free of ice, on Plate XXXIX, the north bay is still frozen and on this Plate still has an iceberg and a floe of growlers. King George Mountain (&), 1800' above sea level, on Plate XXX-2033, is shown here in nearly vertical view with out-cropping layer of darker-toned rock. Curiously, the tidal range here is very small. The beaches are of sand or shingle (2033) with a scant, low vegetation of no significance in trafficability. In the bottom of the valleys there are marshes with their usual soft muck. On the sloping sides, the drier terrain is indicated by the darker-toned heaths (Cassiope tetragona, etc.

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PART III

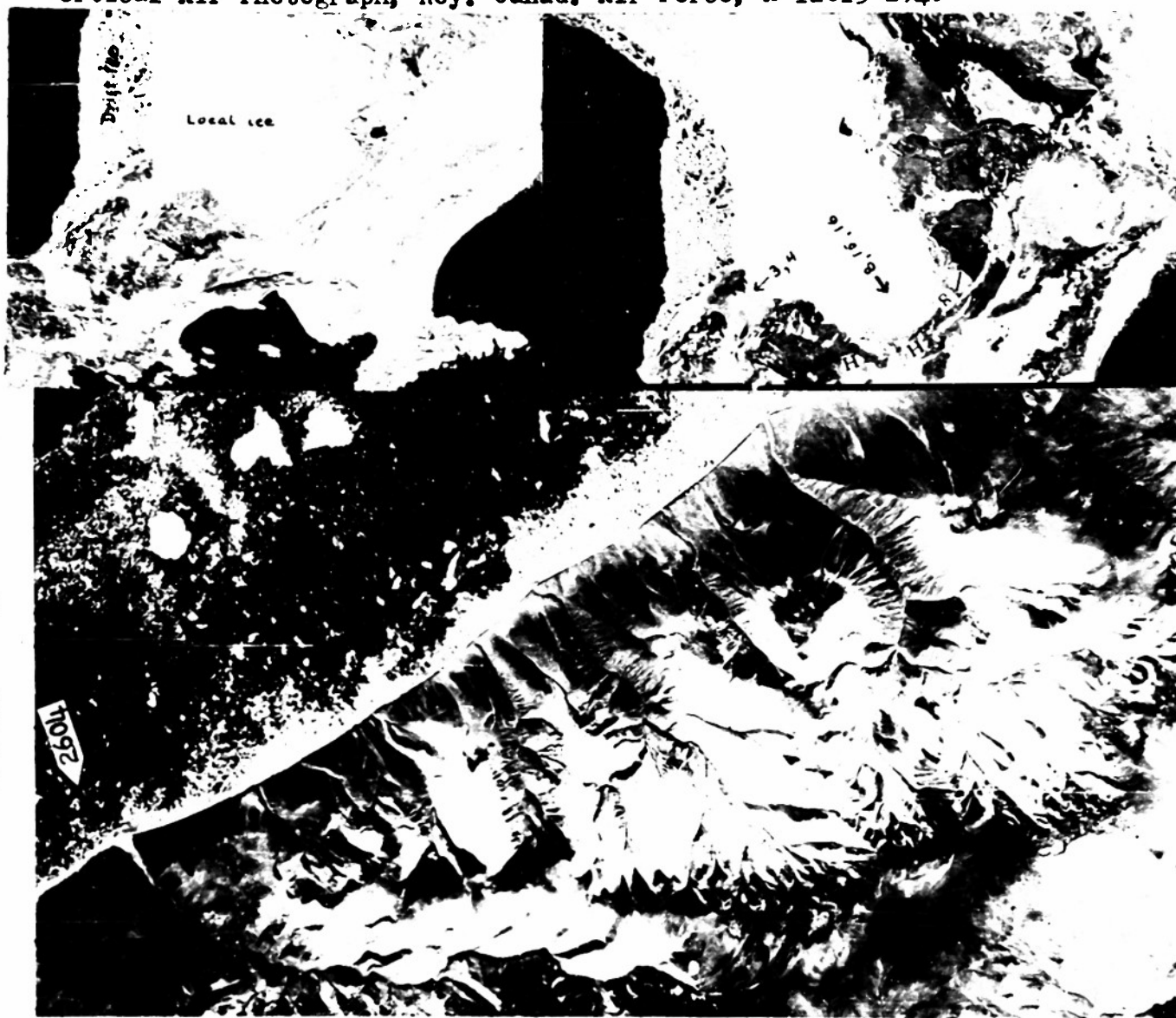
Arctic
Beaches

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PLATE XLI

SECURITY INFORMATION

Port Manvers, Labrador. Panchromatic Oblique and Vertical Trimetrogon Air Photographs, Roy. Canad. Air Force, T 180 L-35 and T 180 C-35. Smoky Mountain, the Arctic Ocean East of the Mackenzie Delta. Panchromatic Vertical Air Photograph, Roy. Canad. Air Force, A 12813-294.



Showing the fine sand beach of Plate XXV 2240 but in winter. (/) is the eskimo's hut, (H) is dark toned heaths on old raised beaches with good travel conditions. The lower air photograph shows the Arctic Ocean and the Shore with the Black Pits Burnt Out of the Layer of Coal in Smoky Mountain. Here the tide is small, about 2 feet with a narrow cobble-gravelly beach at the foot of the steep rocky bank. The importance of a supply of coal (brown coal or lignite), on the Arctic Ocean where coal costs about \$140 a ton, needs no emphasis. This coal has been burning for generations. Note that the Arctic Ocean here is completely blocked with ice for the entire year except for about 10 days when there is enough open water for a boat or for a hydro-plane to land. The sulphurous smell of the smoke from burning coal distinguishes it from a forest fire or a fog.

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KEEP WIDE MARGIN

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RT III

Arctic
Beaches

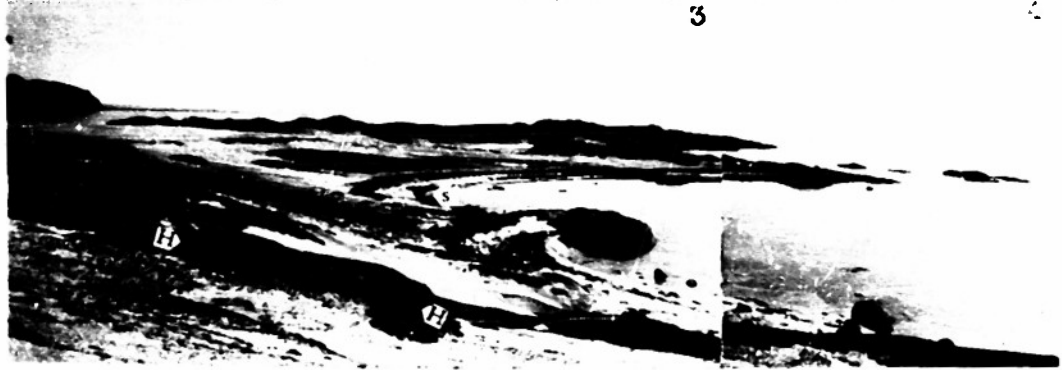
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PLATE XLII

SECURITY INFORMATION

Ground Photographs to Air Photographs on Plate XLI, T180L, C-35, Port Mary, Labrador. Landing Conditions Changing Annually by Iceberg-dropped Boulders Sometimes Indicated by Gaps or Abrupt Juttings in the Otherwise Continuous Regular Dark Lines of Dead Seaweed. See Plates XXXV and XXXVI, 2092.

3



Dark lines on photographs of arctic beaches often indicate the terrain conditions on the beach. Continuous, dark regular relatively thin lines parallel to the shore-line indicate a sandy beach, when these lines are just above the average high tide level. This dark line is a row of dead seaweed (s). Less regular and often wider dark bands further up the beach are rows of heath bushes, a foot or two high. They indicate dry terrain and frequently, as here, raised beaches. In the panoramic 3 and 4, many icebergs in the background are shown driven on-shore by the prevailing wind to their graveyard where they melt away and deposit a new crop of boulders annually, altering the landing terrain from year to year. The air photos on Plate XLI show the short stretch of this fine beach occupying only the cove. 15 shows a sand dune high up on the beach, really an old raised beach. The dwarf prostrate form of the black spruce crowning the dune is an example of adaptation of a plant normally forming trees, here taking the shape of a mat clinging precariously to the summit of the eroding dune.

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16 is a detail of the dune shown in 15. It shows the dwarf prostrate black spruce growing on the sand dune.

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PART III

Arctic
Beaches

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PLATE XLIII

SECURITY INFORMATION

Mouth of the Fort George River, James Bay. Panchromatic Oblique Air Photograph. Roy. Canad. Air Force, T 384-32L. See ground photographs of this area on Plate XXXIII, 7100 and Plate XLIV, 14, 15, 16, 17, 18.



12,007 shows the great depth of alluvial sand on the banks of this river which gives rise to the well-drained terrain indicated by pure stands of white spruce (W), (single spruce on 13) and permitting rough and ready roads (12) almost anywhere.

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Mouth of the Fort George River, James Bay. Ground Photographs of Beacon Island, by G. Gardner, Sept. 1939. See also Plate XXXIII, 7100. Vegetation Indicating Microclimates in Small Areas on a Small Island.



In order to deduce terrain conditions at the mouth of a river, the photo-interpreter will do well to note the distance from the mouth to the first rapids or waterfall. The great rivers such as the Albany and the Attawapiskat, entering James Bay from the west, have the first rapids about 40 miles or more inland, while those emptying into the Bay from the east have the first rapids or cataract much nearer the mouth. The western streams of low velocity deposit very fine particles at their mouths and so have a clayey, poorly drained terrain and soft muddy beaches, as described and illustrated on Plates XXXII-XXXV. In marked contrast the great rivers descending from the Labrador or Ungava plateau and entering the Bay from the east have the first cataract or rapids much nearer the coast, and so enter the Bay with a higher velocity, carrying large particles, i.e. sand. As a result, the mouths of these

rivers have prevailing sandy or rocky shores. The area around the mouth is a coarse sandy, well-drained loam. This terrain is indicated by the white spruce replacing the black spruce. The deposit of alluvial sandy loam on the banks is, in places, often deep and conspicuously layered as shown on 12700 (a section of the bank of Great Whale River). Such a situation is an excellent site for a landing field (e.g. at Geose Bay, at the head of Hamilton Inlet), for road construction and is about the only site suitable for agriculture in this region of vast black spruce forest. 15 is early snow on Beacon Island (7100 on Pl. XLIII). 14, 16, 17: scant vegetation on windswept NW slope and top of the island; 18: rich vegetation on wind-protected SE slope. (h) mare's-tail (Hippuris vulgaris).

14, 16, 17: scant vegetation on windswept NW slope and top of the island; 18: rich vegetation on wind-protected SE slope. (h) mare's-tail (Hippuris vulgaris).

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B: black spruce.

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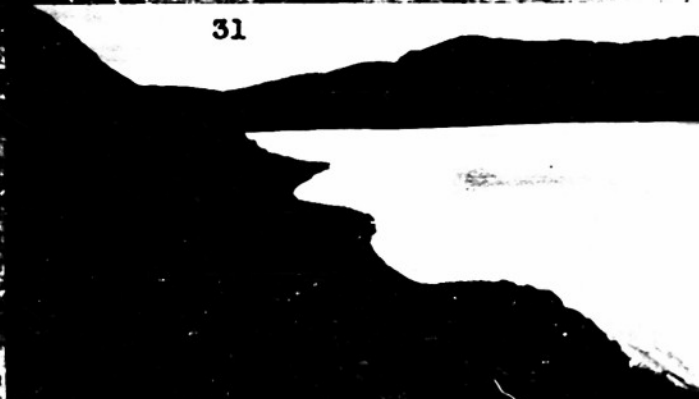
Arctic
Beaches

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PLATE XLV

SECURITY INFORMATION

Wakeham Bay in the South Shore of Hudson Strait. Panchromatic Oblique Air Photograph, Roy. Canad. Air Force, T 197L-127. A deep fiord about 7 miles long with a tide about ten feet high and abundant growth of large seaweeds. Glacial erosion on the shield area.



An area scoured by the ice sheet with practically no glacial till. The hard rock is close to the surface, covered only by a thin layer of humus supporting a tundra growth mostly of heaths about 6 inches tall as in the steep bushes of the birch on 31. The footing is firm everywhere except along shores of the small ponds and streams. In the sheltered valleys there are bushes of birch about 3' tall somewhat obstructive to walking. The terrain is too rugged and too frequently and too deeply furrowed to allow travel in a jeep for very short stretches.

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Part III

SOME TERRAIN CONDITIONS
IN THE
SPRUCE FOREST REGION
DEDUCIBLE FROM AIR PHOTOGRAPHS

Test Location:

Elevation: approximately 150 to 200 feet
above sea level.

Matanuska Valley, Alaska.

Farmed Land interspersed with
subarctic spruce-birch forest

Illustrated by
A-series of Plates

Ground and Large-scale Air Photographs
and Field Information

by

Herbert C. Hanson

June 1952.

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C PART III

**SUBARCTIC
SPRUCE REGION**

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**PLATE
A - 1**

Matanuska Valley, Alaska. Stereo Panchromatic Air Vertical Photographs,
1/10,600 approx. (reduced from 1/10,000) by Nine-lens Camera, U.S. Coast
and Geodetic Survey, 2:30 P.M., July 14, 1948. 22593, 22592 (right).

TECH. REP. SIX

KEEP WIDE MARGIN



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SUBARCTIC
SPRUCE REGION

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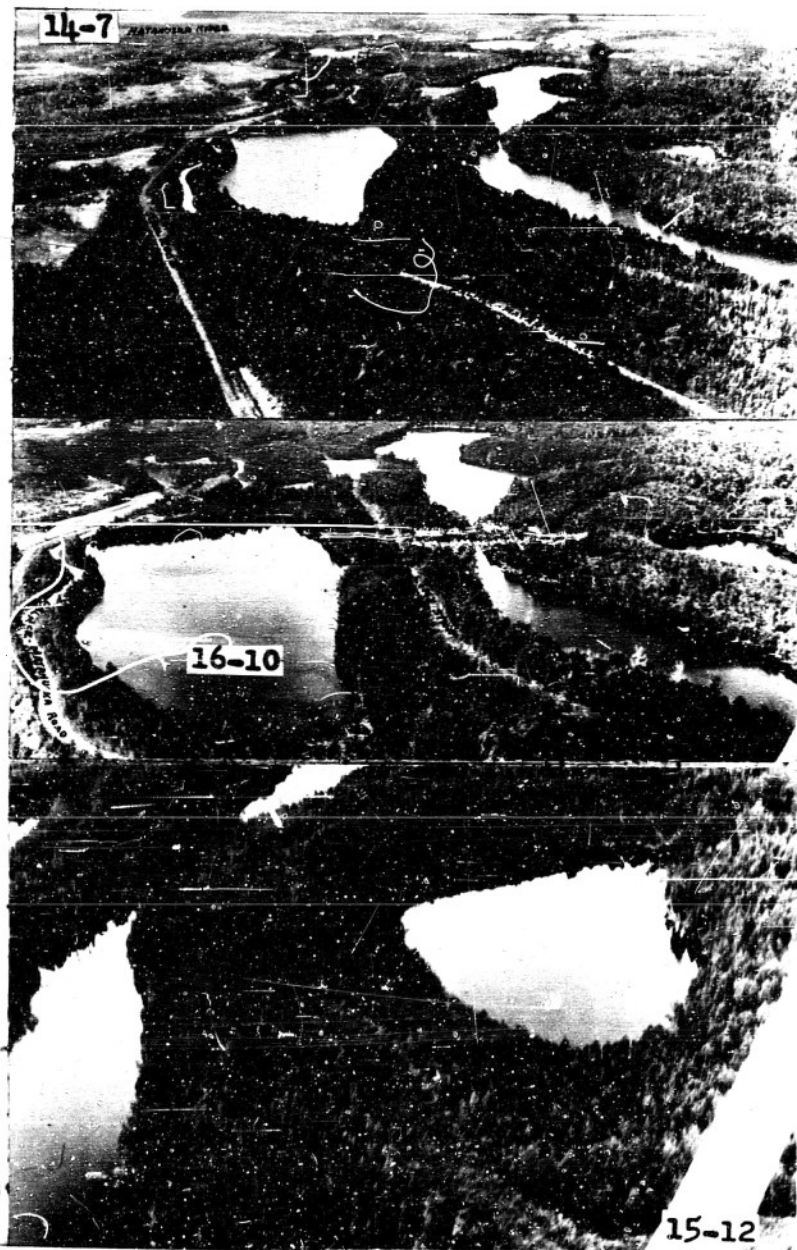
PLATE
A - 2

PART III

Matanuska Valley, Alaska. Air oblique Photographs Showing Details of Plate A-1. Taken by H.C. Hanson July 1-July 4, 1952. Spruce-birch Forest on Glaciated Terrain with Characteristic Elongate Numerous Lakes.

This series of nine plates illustrates a glaciated area in the subarctic region, where the ice cap has recently melted away roughly a few thousand years ago. It is mostly an area covered by a thick surface deposit of glacial till completely unconsolidated, much of it reworked by rivers and streams.

The terrain reflects the difference in the character and above all the drainage conditions, which are recognizable from air photographs by the landforms and the vegetation. Here as everywhere else in the world (except areas of lowland rice farming) all farmland indicates fairly well drained land and corresponding travel conditions. Farm crops cannot be grown in water-logged permanently wet areas. In Alaska perhaps less than one fourth of one percent of the land is suitable for farming. This is land commonly surfaced by a layer of wind blown soil (loess) overlying a layer of porous subsoil, mostly gravel resulting from glacial till that was reworked more or less by rivers (outwash). A birch forest is the common indicator of such terrain. More or less white spruce is commonly mixed with birch. Where deposit of loess is thin, and the drainage too rapid, not enough water is retained in the soil for the growth of trees. Such a thin coat of loess on gravel outwash appears to be at least part of the reason for the "northernmost prairie in the world" at Big Delta, Alaska, where there is the most northerly herd of buffaloes. Such a "prairie" of grasses and legumes registers in very light tones on air photographs and does not show the concentric patterns of the marshes. Light-toned aspen (a nearly pure stand on 16-10) shows where a forest was destroyed by fire.



(Continued on Plate A-3)

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SUBARCTIC
SPRUCE REGION

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PLATE
A - 3

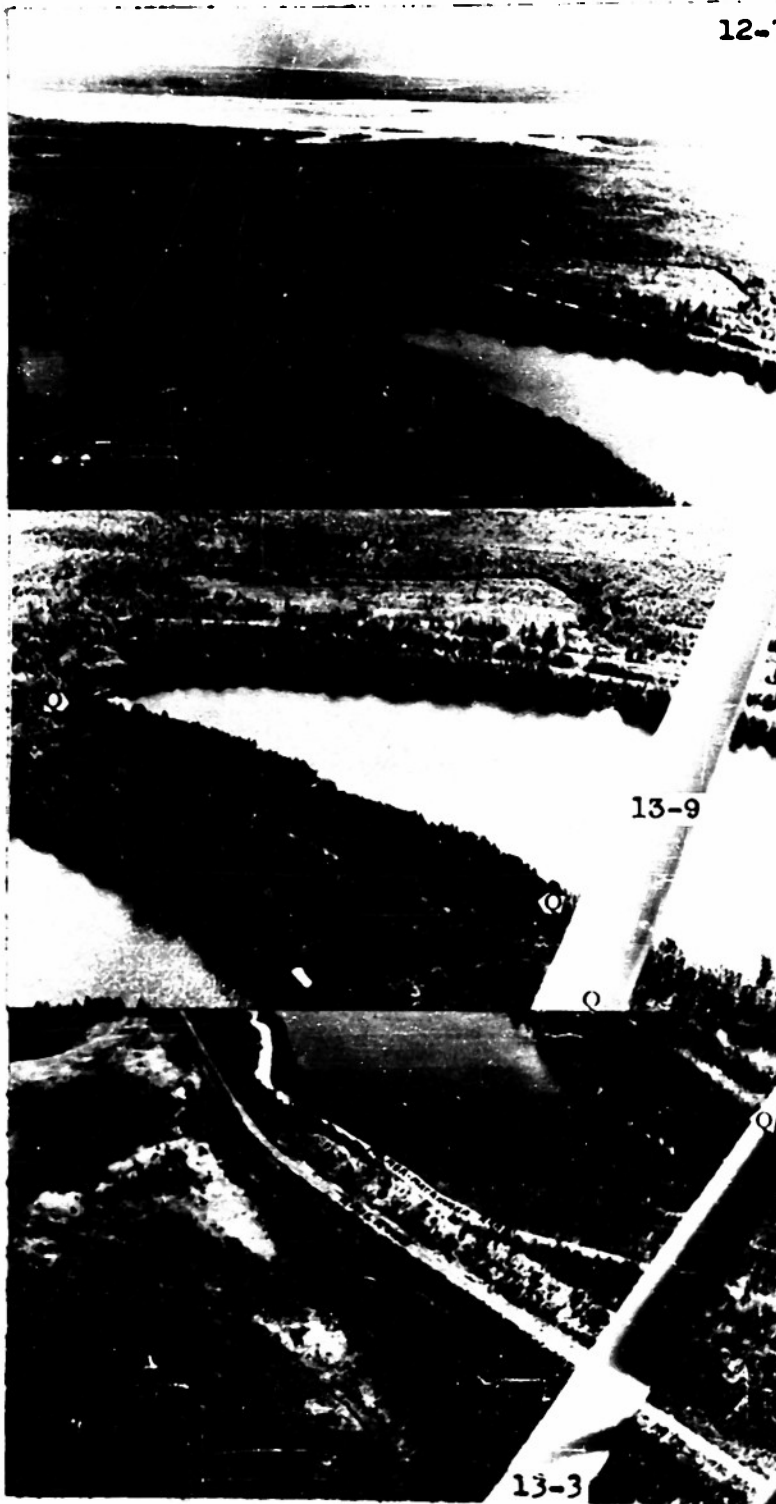
C PART III

Matanuska Valley, Alaska. Air oblique Photographs Showing Details of Plate A-1. Taken by H.C. Hanson July 1, 1952. Spruce-birch Forest on Glaciated Terrain with Characteristic Elongate Numerous Lakes.

(Continued from Plate A-2)
Stands of cottonwood (C) (balsam poplar, *Populus trichocarpa*) in this part of Alaska, forming the tallest trees (up to 100') indicate very well-drained areas, usually gravelly river banks or eskers (gravel deposits laid down by rivers that formerly flowed under the melting glacier.).

The rock flour washed out of the gravel by rivers and deposited farther down stream covers very large areas in Alaska, often along river banks, especially estuaries on tidal flats where it affords firm footing for travel by jeep or pedestrians. The soft muck of the bogs is not formed of this glacial material but of humus and water-logged early stages in the formation of peat. The pure stand of aspen (*Populus tremuloides* L.) on the left of the lake in 13-9 and the right of the same lake in 13-3, taken when the plane was facing in the opposite direction is an excellent example of how this tree, probably the most common tree in the subarctic and cool temperate regions of North America, takes possession after a forest has been destroyed. Wherever the spruce-birch forest has been destroyed, it is the common tree. The foliage on this tree turns a brilliant yellow in Fall, and even in early August if the summer has been dry.

12-7



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PART III

SUBARCTIC
SPRUCE REGION

SECURITY INFORMATION

PLATE
A - 4

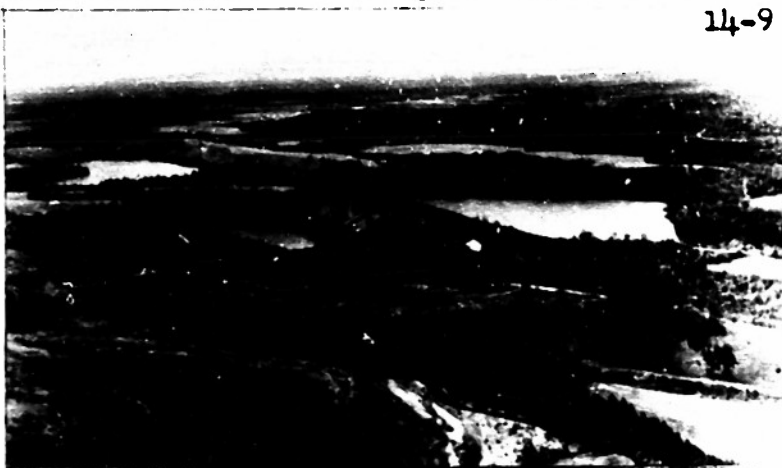
Matanuska Valley, Alaska. Air oblique Photographs Showing Details of Plate A-1. Taken by H.C. Hanson July 1-July 4, 1952. Spruce-birch Forest on Glaciated Terrain with Characteristic Elongate Numerous Lakes.

14-9

This series of Plates A-1 to A-5 are excellent examples of how the photo-interpreter can use landforms and type of vegetation together in deducing terrain conditions. Obviously the lakes shown here are formed by the damming of river valleys by glacial deposits. The pattern or zonation of vegetation around these lakes shows very little of a zone of marsh. From this lack of zone of water-lilies and sedge marsh, it can be inferred that the banks are relatively steep, not soft underfoot and the water is at least deep enough for landing hydroplanes.

16-11 shows the dark tone of the white spruce in upper left corner contrasting with very much lighter toned birch, aspen and cottonwoods on the rest of the photograph.

12-5 shows in the right middle ground a marsh also with a few dark-toned spruces, probably black, not white spruce. Except on very large scale picture it is usually impossible to distinguish black from white spruce. However, because the black spruce and not the white spruce commonly grows in waterlogged soil, it can be assumed these are black spruce. Shown at left center of 12-5, near center of 14-9 is an abandoned farm invaded by the commonest grass in the American subarctic called "red-top" locally, (*Calamagrostis canadensis*), fireweed (*Epilobium angustifolium* L.) the commonest weed in the American subarctic, and other weeds. Also invading are bushes of willow, plus young birch and white spruce trees. Eventually the vegetation here will be a forest of birch and spruce. This is an example of what is meant by the term "climax" of ecologists.



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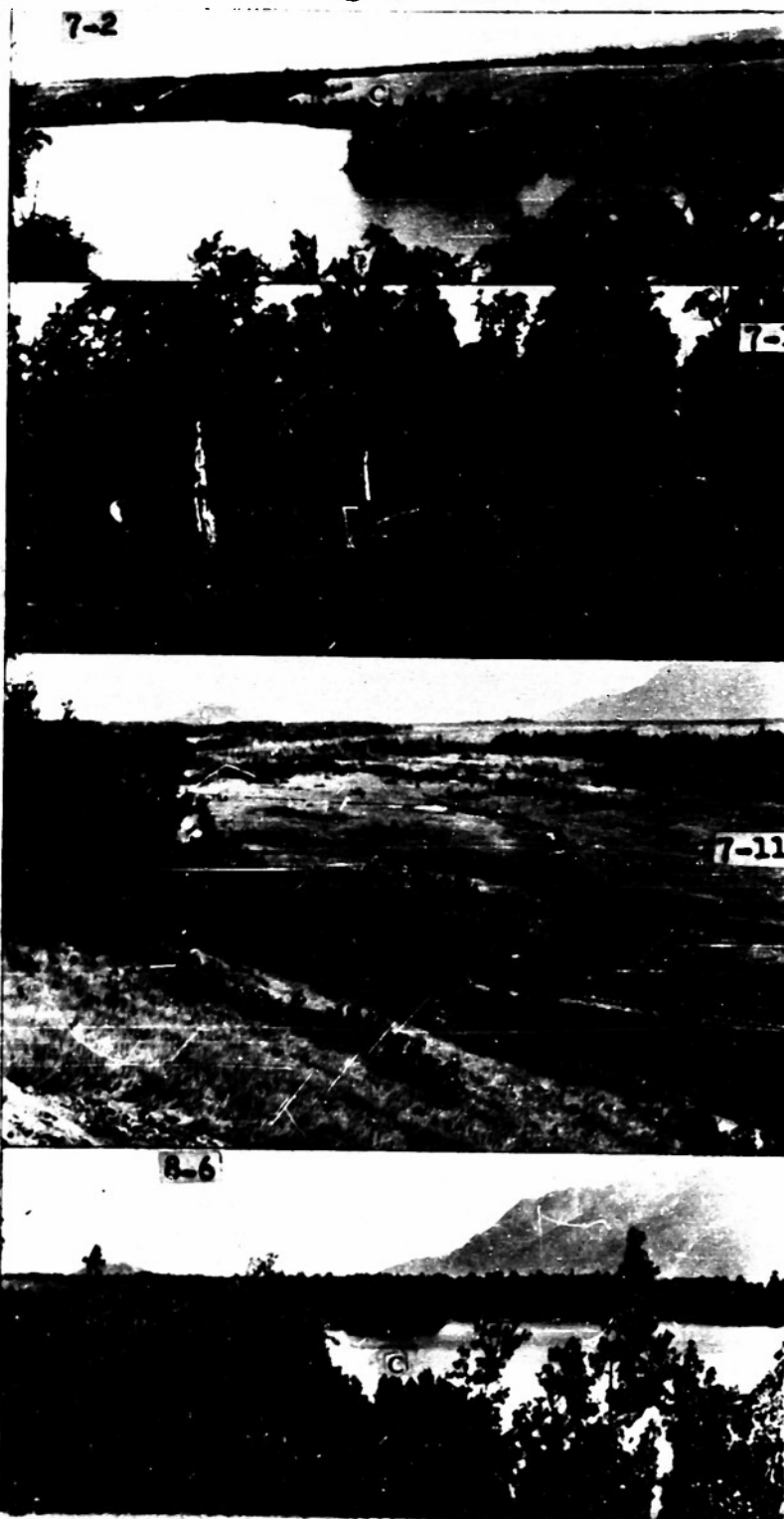
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Matanuska Valley, Alaska. Ground Photographs Showing Details of Plate A-1. Taken by H.C. Hanson June 24-June 25, 1952. Spruce-birch Forest on Glaciated Terrain with Characteristic Elongate Numerous Lakes.

The presence of a white spruce-birch forest on the peninsula in the center of 7-2 clearly indicates well drained soil there. The white bark of the birch greatly facilitates its recognition on oblique and often on nearly vertical air photographs. The left third of the peninsula is covered by a stand of cottonwood (C) with a border of alders in front of them. The alders throughout the arctic, sub-arctic and temperate regions of the Old and New World very commonly indicate the boundary between the forest on the one hand and either marsh or a body of water on the other. Alders may also indicate the presence of seepages (flushes in England). 7-1 shows the conspicuously white bark of the birch with an abandoned field in the foreground. 7-11 shows an example of zonation where the darker vegetation bordering the small stream, a stand of horsetails (*Equisetum fluviatile* L.) indicates the presence of shallow water (about 6" deep). The lighter-toned marsh, a sedge marsh (*Carex*) indicates wet ground with a water table at the surface. 8-6 shows a hedge or row of young quaking aspens in the foreground, cottonwoods and alders on the shores of the lake, and again the mature birch-spruce forest on the same peninsula shown on 7-2.

On 7-11 can be seen in the midst of the field in the foreground, bushes of wild roses with the rose purple blooms registering white.



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KEEP WIDE MARGIN

REP. SIX
ART III

SUBARCTIC
SPRUCE REGION

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PLATE
A - 6

Matanuska Valley, Alaska. Stereo Panchromatic Air Vertical Photographs, 1/2500 approx. by 12" Focal Length Camera, U.S. Air Force. 3:00 P.M. approx. July 3, 1947. 43, 44(right) 72RS P-00V M7M120.

This plate and plate A-6 show a flood-plain with strips or islands of trees. The nearly white tone of the tall trees, as well as their height, helps to identify them as cottonwoods. They indicate that these "islands" have a gravel, well-drained soil. The nearly treeless light-toned zone pointed out by 10-10 is a marsh, probably a shallow filled-in pond. Such a marsh is to be avoided for any kind of travel except in winter when frozen solid.

Such a marsh commonly has one to many feet of soft peat. It is extremely difficult to cross on foot and is always shunned in road-building when it is possible to plan the route where there is or has been a forest to indicate the drier, well-drained ground, especially as here, where the trees are cottonwood, birch and aspen. The driftwood in the large light-toned area in the upper part of the stereo photographs indicates a flood plain. Practically all the trees on these photographs are mainly of these kinds: birch, cottonwood and aspen. Practically all the taller trees over-topping the rest are cottonwood. The abundance of the cottonwoods indicate a well-drained terrain. In fact, when such a woods is cleared off trees and stumps, roads can be laid anywhere with little difficulty.



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Ground Photographs to Plate A-6, Taken by H.C. Hanson, June 30, 1952.
Marshes (Muskegs) and a Stand of Cottonwood Trees in the Spruce-
Birch Forest Region.

10-6 shows a dense stand of vegetation along an old road crossing the marsh, abandoned in 1939. Here the photo-interpreter can use the vegetation as an indicator of the trafficability of this road. If this were a road, ~~any~~ during most of

the summer, then in the space of the thirteen years, cottonwoods, aspens and white spruce would almost certainly be growing there. As a matter of fact the vegetation shows a very even height, characteristic of alders, with no trees showing above the line of the bushes. These are alders and/or willows. It can therefore be safely deduced that this is not a good road. When the project director saw this road in 1947, the road was wet, very little above the level of the marsh and in some places with a rotting corduroy surface. Roads made in subarctic regions are necessarily built with a broad ditch on either side in order to keep the road well-drained and therefore safe from serious heaving in the spring thaws. On such ditches and on their sloping sides, there soon appears long lines of bushes. These are almost always either willows or alders, throughout Alaska and in

very much of the subarctic region throughout the Old and New World. 10-7 shows a very light-toned bush in the foreground. This is caused by the abundant crop of downy white fruits. During July many of the bush-willows (e.g. Salix Barclayi) are almost covered with down and register almost white on any kind of photography. Just as shown here.



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PART III

SUBARCTIC
SPRUCE REGION

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PLATE
A - 8

SECURITY INFORMATION

Matanuska Valley, Alaska. Stereo Panchromatic Air Vertical Photographs,
1/2500 approx. by 12" Focal Length Camera, U.S. Air Force. 3:00 P.m.
approx. July 3, 1947. 44, 45(right) 72RS P-00V M7M120.



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Ground Photographs to Plate A-6, Taken by H.C. Hanson, June 30-July 4, 1952. Marshes (Muskegs) and Farms in the Subarctic Spruce-birch Forest.

10-3 is a view across the bottomlands. In the foreground, the lighter tone and finer texture of the aspen (resulting from the smaller leaves and more slender twigs) is in clear contrast with darker-toned coarser textured crowns of the cottonwoods (with larger leaves and stouter twigs). Zonation is shown by the marsh and tongue of land in the left middle ground with shallow water, horsetails, sedges, willows and alders and cottonwood-aspen woods in successively taller zone on successively drier terrain. The solitary white spruce crown in the foreground is conspicuous by its narrowly conical crown and very dark tone. The white buildings in the upper right corner of 16-12 are the Matanuska Experiment Station.

In the rest of the photograph the vegetation reflects the level of the water table and flood conditions. 10-4 shows a pure stand of young white birch with a field of fireweed and grass (*Calamagrostis canadensis*) in the foreground. Note that in the shade the white bark of the birch is not evident but shows only where the light strikes it.



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TERRAIN CONDITIONS
CORRELATED
WITH VEGETATION
ON
SUBARCTIC AND ARCTIC MOUNTAINS
DEDUCIBLE
FROM
AIR AND GROUND PHOTOGRAPHS

R E S T R I C T E D
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Tech. Rep. 6
Part III

TERRAIN CONDITIONS CORRELATED WITH VEGETATION
ON SUBARCTIC AND ARCTIC MOUNTAINS

Test Location: South Nahanni Valley, N.W.T. Canada.

In general, for purposes of interpreting vegetation from air photographs of the arctic and subarctic regions, it seemed most practical for our purposes to consider this vast circum-polar region primarily under three great divisions of land forms; viz.

Flat-lands (mostly lowlands),
Mountains,
Shield Areas (mostly plateaus).

In this section comprising Plates M-1 to M-30, there is illustrated a mountainous region of relatively recent elevation, showing the rugged topography and steep slopes characteristic of "young" mountains.

As in mountainous regions, anywhere in the world, the principal influence affecting travel conditions is the steep slope of much of the earth's surface, while water-level assumes a very secondary rôle. This is exactly the opposite of travel conditions in the lowlands where slopes is a very secondary influence and water-table of prime importance.

Vegetation modifies travel conditions for better or worse in mountains more than in lowlands. Thus, a stand of alders is always associated with wet soil. On steep slopes the alders are practically an impossible barrier to travel upward and greatly

increase the difficulty caused by the slope. But on lowlands the same alders have a much smaller modifying effect, although the soil is equally wet in both cases.

A rough idea of the extent of the mountains in the arctic and subarctic regions of USSR is shown on Map 6, the last section of this report. The information shown and explained on the following thirty plates can be used as an introductory study in the photo-interpretation of the vegetation on these mountains. The parallel is likely to be closest between the vegetation on the mountains of Kamchatka and the Nahanni Valley, at least as regards the masses of vegetation. Both are regions of recent uplift as shown by the presence of hot springs, the very steep slopes, etc.

From a military standpoint, it seems safe to consider such mountains as an impassible barrier to an army until a substantial road has been built across them. The photo-interpretation of vegetation is likely to be of little use to the engineer in laying out such roads. But from another military standpoint, that of small reconnaissance parties or small detachments, the mountains of the arctic and subarctic are passable. It is for this purpose that the following plates have been prepared. From the present study and the general information accumulated by our Arctic Institute the following generalizations have been laid down for the photo-interpretation of this and other mountains of similar climate:

1. In general, detachments larger than reconnaissance

parties, will find the most practical routes of travel in the larger valleys and across the relatively few passes. Vegetation in the valleys is a fair indicator of the travel conditions there as shown on the following plates.

2. Small Reconnaissance and/or scouting parties will find the best travel routes in such mountains to be game trails.

Pl. M-24

3. Such game trails follow the line of ridges or the relatively even ground on the sides of slopes. If the valleys are relatively wide and flat, these trails will follow the banks of the streams. Be it noted that moose trails often terminate at marshes and bogs, but caribou, mountain goats and sheep trails stay entirely in drier ground. Pl. M-28

4. The top of the ridges of medial moraines, although relatively uncommon, are good routes of travel. Pl. M-10, M-26, M-27.

5. Braided streams are good routes of travel although frequent fordings to cross and recross the stream channels are necessary. Braided streams in themselves indicate the place where the slope is less than the rushing torrent that feeds them. Pl. M-3, M-4, M-9, M-12, M-15, M-16, M-19, M-25, M-28, M-29.

6. White spruce forests on the banks of streams or the lower slopes of the mountains, indicate good travel routes, free of obstructive underbrush and relatively dry terrain. Pl. M-1, M-3, M-4, M-7, M-8, M-18, M-19, M-25, M-28, M-29, M-30.

R E S T R I C T E D
Security Information

Tech. Rep. 6
Part III

M-Series
4

7. Birch-covered slopes with bushes not taller than waist-high afford the best and driest means of ascending slopes. Pl. M-3, M-19, M-23, M-24 4-1, M-25 B-2.

8. In contrast, slopes covered with willows and alders are the wettest and worst routes of ascent and descent especially in "Draws". Pl. M-2, M-12, M-13, M-14, M-16 75-8.

9. Large boulders and flat rock surfaces covered with reindeer moss (Pl. M-20), offer a slippery hazard footing wherever they occur. Pl. M-11, M-30.

10. A spruce forest recently burnt over, is soon filled with a dense growth of willows which with the fallen dead branches makes a very obstructive thicket. Pl. M-21.

11. On the other hand a spruce forest killed by flooding indicates deep mud.

12. Black spruce-larch forests indicate swamps and poor travel conditions. Pl. M-21, M-22, M-24 13-4, 13-3.

13. In some of the streams it is possible to travel by rafts where the current is not too swift. Pl. M-7, M-29.

14. Rock slides or talus slopes should be ascended at an oblique angle. The amount and height of the vegetation (Pl. M-14) on such slopes is an indication of the stability of such a slope. Total absence of vegetation (Pl. M-2 and M-5) indicates an actively sliding slope to be avoided. Pl. M-1, M-2, M-5, M-6, M-21 115-1, M-22, M-26, M-27.

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15. In general glaciers especially when snow-covered are to be avoided unless there is at hand suitable equipment. Pl. M-10, M-26, M-27, M-30, M-11. Mosaic shows many glaciers.

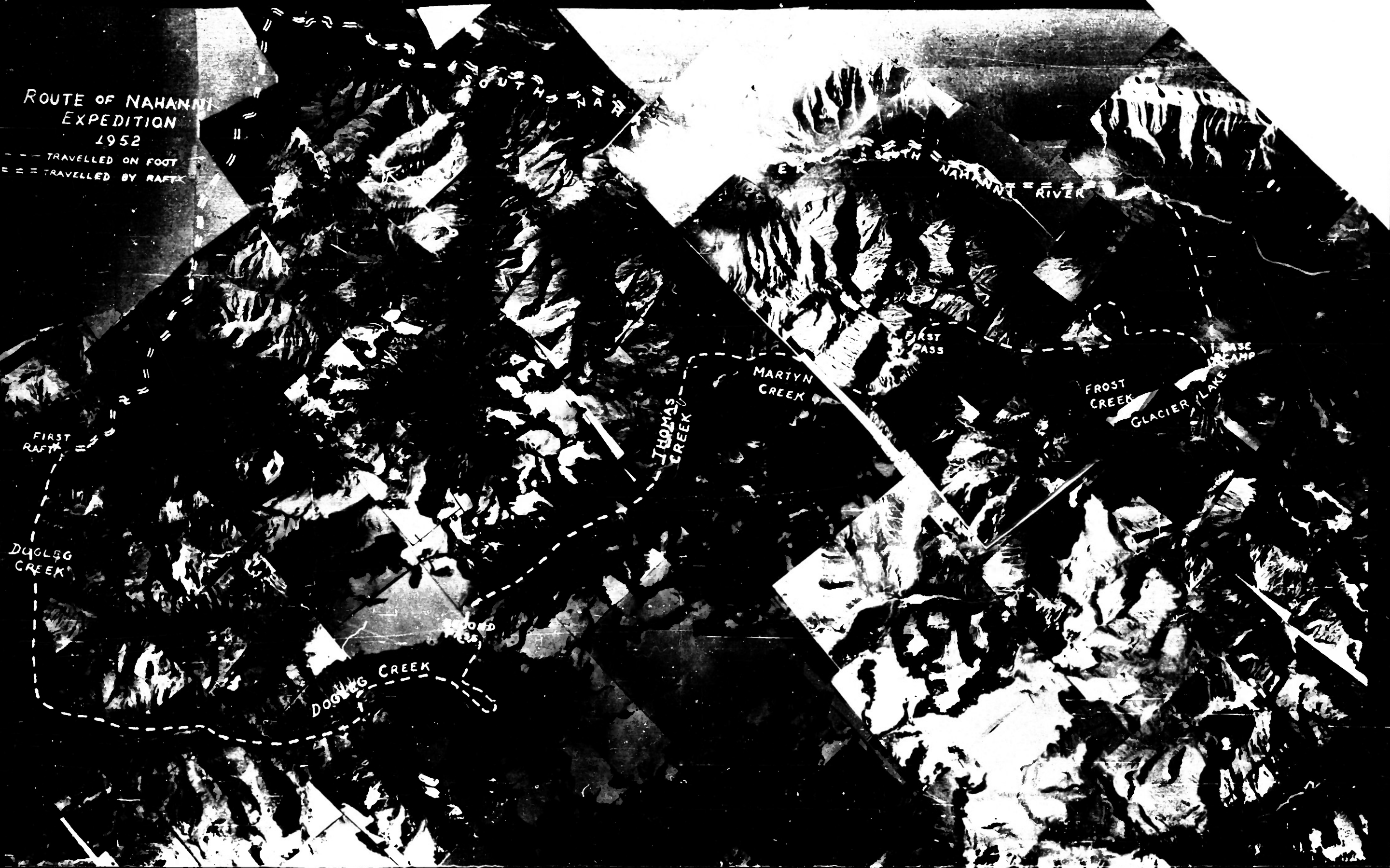
This spring was abnormally late. The glaciers which ordinarily begin to melt rapidly about June 15, were delayed this year at least two weeks. The seasonal aspect, especially the color of the early foliage, was correspondingly retarded, a fact that would show on color much more plainly than on black and white photography.

The ground photographs used in this series of Plates M-1 to M-30 were all taken by Norman Thomas for Richard Shamp (in whose file the negatives are kept). Howell Martyn is responsible for a considerable part of the notes on the terrain.

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ROUTE OF NAHANNI
EXPEDITION
1952

--- TRAVELLED ON FOOT
=== TRAVELLED BY RAFT



SUBARCTIC MOUNTAINS

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PLATE
M - 1

III

Near the Headwaters of Dog-leg Creek, N.W.T., 62°N. 128°W. approx. Stereo Panchromatic Air Vertical Photographs, 1/20,000 approx. Roy. Canad. Air Force A-12270-90, 91 (left). Showing the Difficulties of Travel along Four Different Types of Streams in Mountainous Terrain.

KEEP WIDE MARGIN



TECHNICAL REPORT No. 5 DEALS WITH THE PHOTO-INTERPRETATION OF SHIELD AREAS, A LARGE PART OF THE ARCTIC AND SUBARCTIC. THE LOWLANDS OF THESE REGIONS ARE DEALT WITH IN THE PRECEDING PAGES OF SECTION 3 OF TECHNICAL REPORT No. 6. THE MOUNTAINS, ANOTHER LARGE SECTION OF THESE REGIONS, IS TREATED IN THIS PART WITH THE FOLLOWING SERIES OF PLATES.

In the mountains of the Arctic and Subarctic, in contrast to the flat lowlands, the principal factor governing travel and terrain conditions is not the water-level or water-table, but slope. Therefore, in general, the first consideration in planning travel routes is finding the easiest grades. This is usually sufficiently evident from stereo aerial photographs as is shown above, and/or contour maps. Such maps show neither perched water-tables or other water-levels, nor the vegetation. Aerial pictures do show the vegetation, which in turn often shows water-levels and other terrain conditions. The pictures enable the photo-interpreter to determine the type of vegetation and from this the water-table. When the kind of vegetation, water-table, and slope are known, the photo-interpreter should be able to indicate on the photographs the better as well as the worse travel routes.

The following series of aerial and ground photographs of the S. Nahanni district of the Mackenzie Mtns. in NW Canada show how the PI can recognize vegetation and terrain conditions in this rugged, mountainous region, and by inference and analogy, to a great extent in any other mountainous region of the Arctic and Subarctic. [Symbols. E: scrub birch; g: granite; h: reddish shale; j: grayish shale; s: snow; S: willow; R: reindeer moss; W: white spruce.]

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P L A T E
M - 2

SUBARCTIC MOUNTAINS

SECURITY INFORMATION

ART III

Waterfall (175' high) about 1/4 mile South of Thomas River, N.W.T. Mountain torrents are poorest travel routes in such terrain.

KEEP WIDE MARGIN
TECH. REP. SIX



In contrast to the flat lowlands, and to a considerable extent the shield areas of the Arctic, the rivers in mountainous regions are much less important and much less used as travel routes because they are too swift and full of dangerous rapids, as shown above and on the next plate. Canoe travel, so much used in the lowlands in the shield areas of Canada, is not usually feasible except in lakes and on some stretches of the larger rivers. On the other hand, for land travel in a mountainous region, the banks of the rivers, where not too steep, are nearly as important as they are in the lowlands. But mountain torrents, small streams and "draws" are practically always the worst routes.

Again, in contrast to the flat lowlands, where slope is of little consequence, vegetation of some importance, and high water-table by far the most important factor; the slope is the main factor, vegetation may be of considerable importance, while high water-table is least important of the factors governing travel conditions in the mountains, because there are relatively only very small areas in the mountains where the water-table is at the surface (obviously on steep slopes the run-off is too rapid to permit the sufficient accumulation of water).

Overland travel in such rugged mountainous country is extremely limited on account of very steep slopes prevailing almost everywhere. Water-logged terrain, such as bogs, are relatively rare; underfoot conditions are, however, usually not bad on account of high water-table, but almost entirely on account of the extremely steep slopes, the sliding, loose rock fragments (talus) on the slopes, and the often dense tangle of bushes or thickets of willows, birches, and alders. At higher elevations, the loose rock fragments are often covered with slippery lichens such as the very common (light-toned) reindeer moss, making travel difficult and even hazardous. Still higher up, glaciers and snow fields present their own difficulties to the traveller. (Cont'd on Plate M-3) [B:black spruce; E: birch; H:heaths; Q:aspen; S:willow; t:limestone talus; W:white spruce.]

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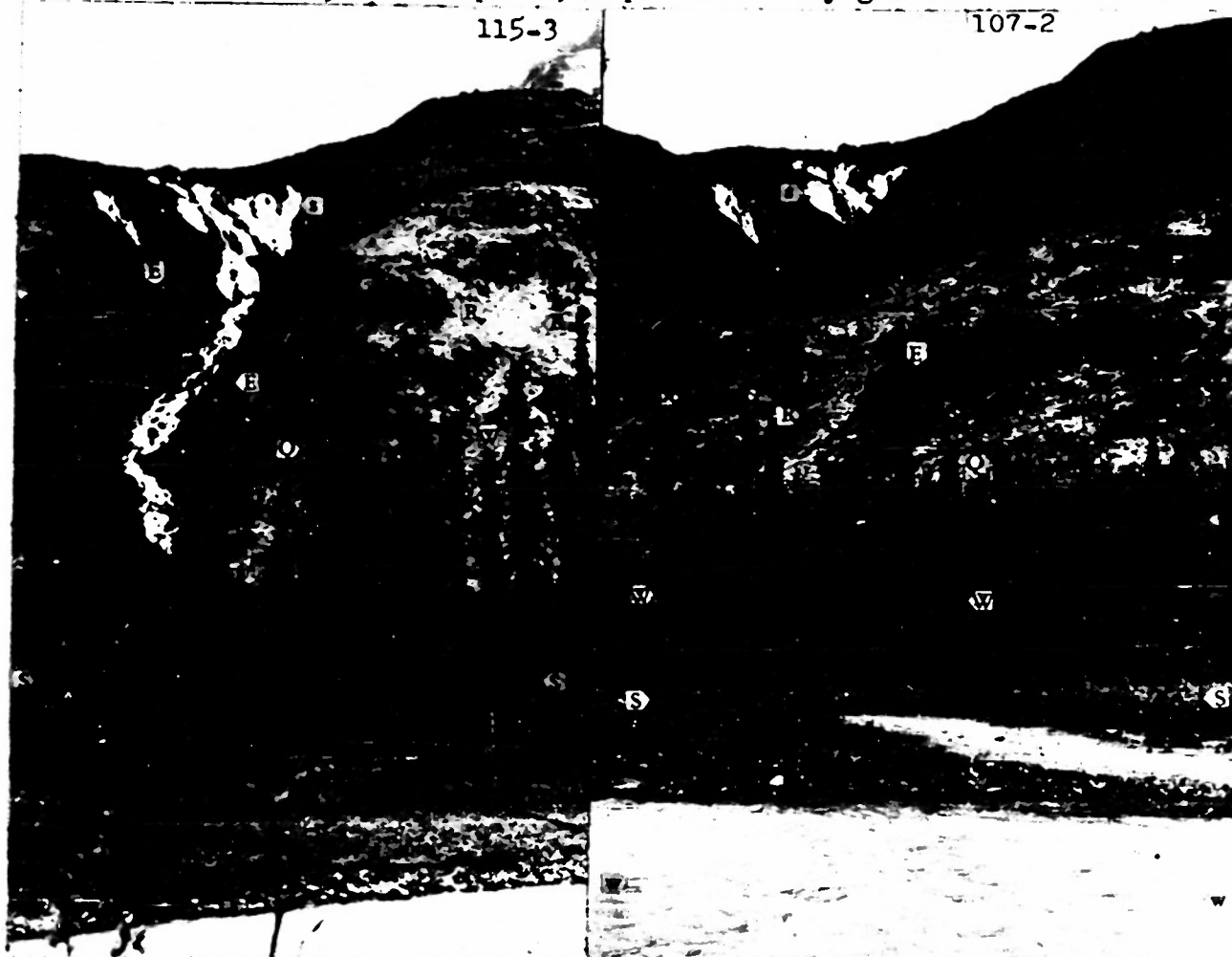
ART III**SECURITY INFORMATION**

Ground Photographs to Air Photographs A-12270-90, 91. Waterfall, reindeer-moss, white spruce, aspen and milky glacier-fed stream.

115-3

107-2

KEEP WIDE MARGIN
TECH. REP. SIX



(Cont'd from Plate M-2) Deposits by glaciers (medial/lateral moraines, or glacial till) are sometimes so laid down as to serve as good travel routes. [Especially Plates M-10, M-15, M-26, M-27]

Once again in great contrast to the lowlands of the Arctic, mud is seldom an obstacle to the traveller.

The waterfall on the photographs above is readily identifiable on Plate M-1. The white snow [s] in the ravine contrasts with the light gray of the reindeer moss [R]. The hillside is largely scrub birch [E] and reindeer moss, both indicating a relatively dry terrain; the shale on this steep slope is tilted parallel to the direction of the slope and is a slippery slide when the overlying reindeer moss is wet. The scrub birch is a help to travel on this steep slope as it is not dense enough (due to the thin soil cover) to impede walking. This hillside would afford the best route of ascent. To follow the snow-covered torrent would be impossible.

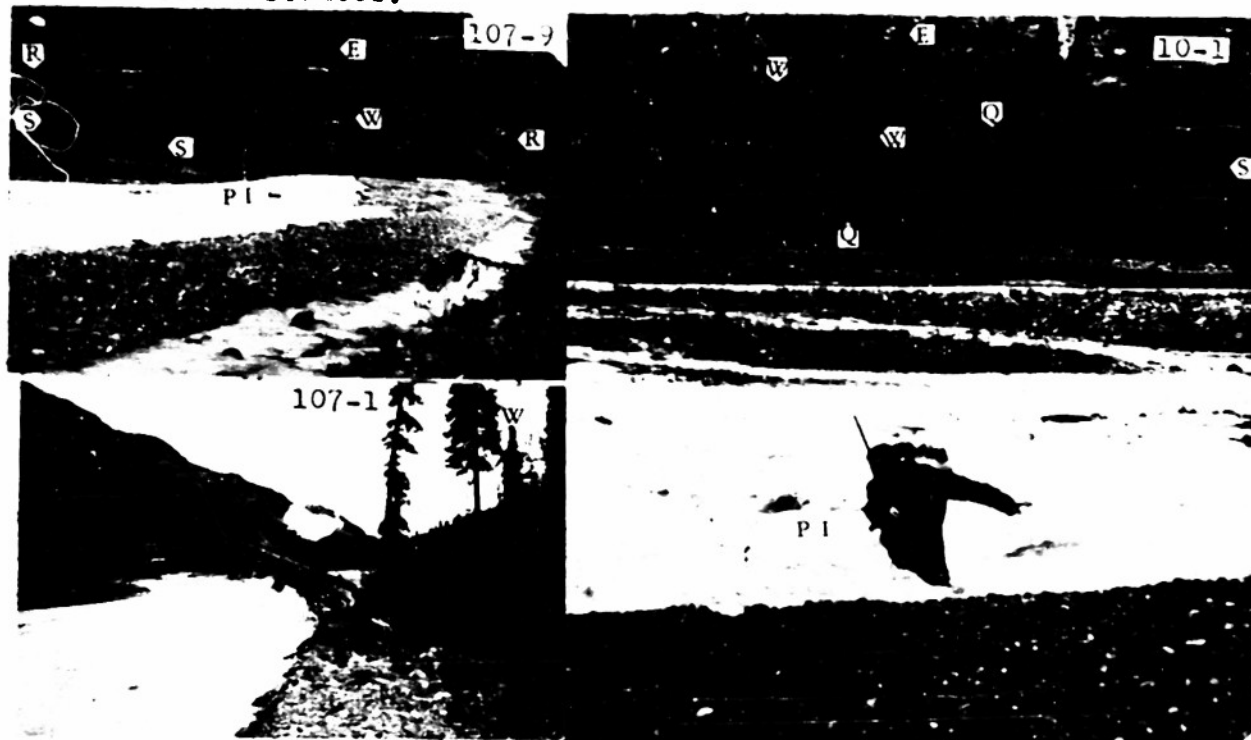
In the foreground is shown a milky glacial stream [w], which has deposited coarse gravels and cobbles reworked from the glacial deposits upstream; these flats afford excellent walking. The bushes on the gravel are willows [S]; further in, the light-toned aspens [Q] are in great contrast to the dark-toned white spruce [W].

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PART III

Ground Photographs to Air Photographs A-12270-90, 91. Swift Glacial Milky Torrent and Photo-interpreter Working under Somewhat Unfavorable Circumstances.

KEEP FIDE MARGIN
TCH. REP. SIX



On account of the steeply sloping terrain the mountain torrents are very swift and carry an immense amount of material. Only the very largest boulders, cobble and gravel are dropped, but in such great quantity that the stream changes its bed almost every year. These gravel deposits are very well drained and usually provide excellent routes of travel except for the fact that it is frequently necessary to cross from one side to the other; big game (including PI's!) usually takes advantage of such gravelly flats. Mountain torrents like this one are generally not too deep, but the rushing waters are commonly difficult to ford, are irregular in depth and hence treacherous; e.g. 107-9: shows the stream which was moving large boulders as well as the photo-interpreter (PI).

107-1: trees on the bank felled in order to serve as a holdfast in crossing the stream are usually carried swiftly away, as was the case here.

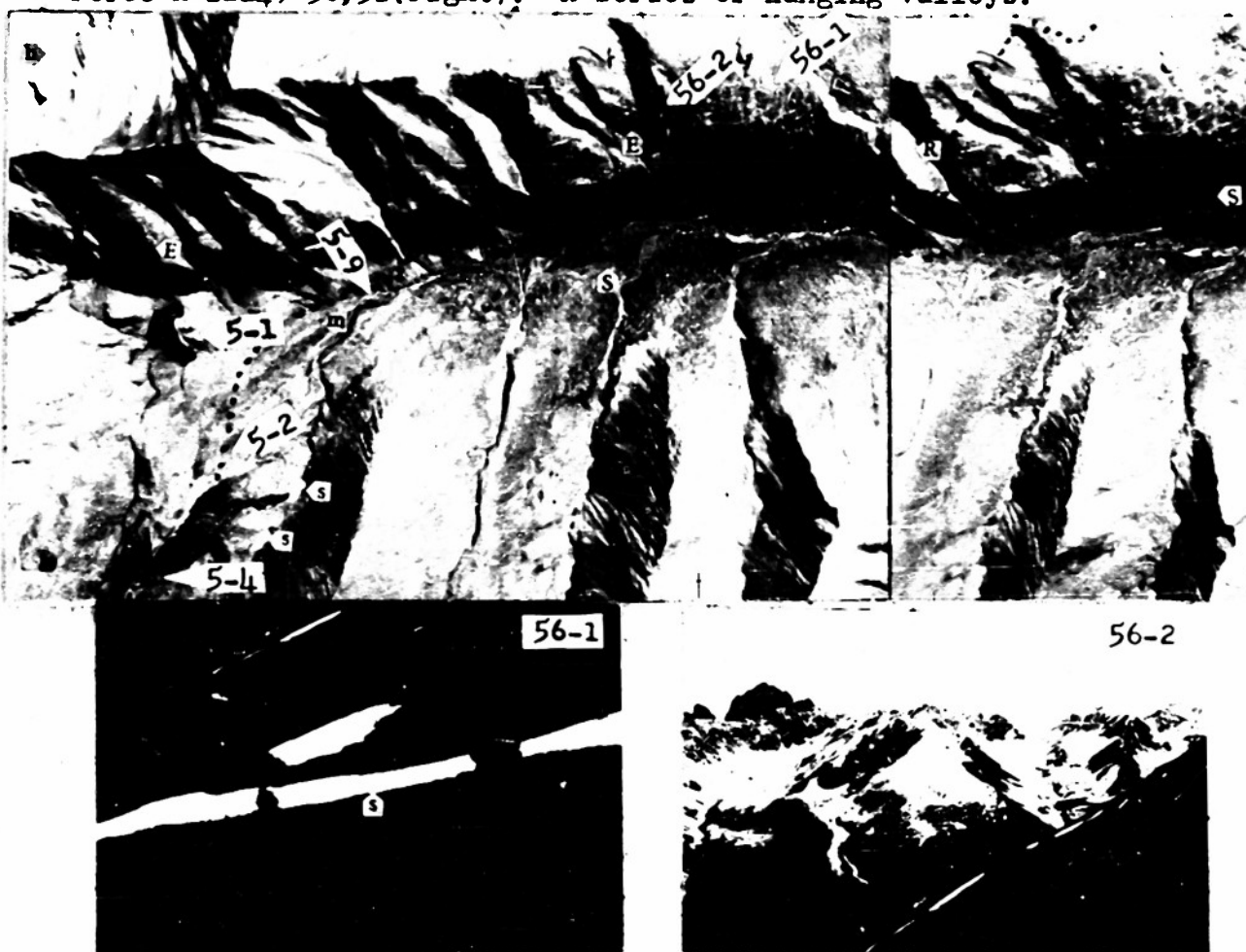
10-1: further illustrating the difficulty of fording such glacial streams. In the background the quaking asp [Q] is readily recognizable by its very light-toned bark and thin, light-toned crown, in contrast to the dark-toned white spruce [W]. Both indicate relatively dry terrain with commonly more or less open vegetation not obstructive to foot-travel. [E:scrub birch; PI:photo-interpreter; Q:quaking asp; R:reindeer moss; S:willow; W:white spruce.]

T III

SECURITY INFORMATION

Frost Creek near Glacier Lake, N.W.T., 62°N.128°W. approx. Stereo Panchromatic Air Vertical Photographs, 1/20,000 approx. Roy.Canad.Air Force A-12249-50,51(right). A Series of Hanging Valleys.

TECH. REP. SIX
KEEP WIDE MARGINS



The photo-interpreter will do well to remember that nearly all the mountains except the highest peaks in these regions were at one time covered by a thick ice-cap. When the ice melted away it left its traces everywhere on the landscape, such as the numerous hanging valleys shown here. These rapidly eroding streams have steep, relatively dry, well-drained slopes, on which vegetation, if present at all, is principally scrub birch [E].

56-1 shows a talus (shale) slope, where the loose rock fragments afford only a sliding footing [also Pl.M-6(5-4)]. The lack of vegetation on the talus slope can be taken as a sign that it still slides readily (56-2). On the other hand, the presence of vegetation is an indication that the talus has become stabilized. (Pl.M-6(5-2), (5-9))

On the banks of the main valley the vegetation is almost entirely thickets of willows [S]. Above the line of the lips of the hanging valleys are birch bushes [E] which constitute most of the vegetation.

True mosses [m] are common on the moist flats of the upper part of the stream (near lake). Conspicuous absence of alders on the lower slopes of the main valley is evidence of the dryness (lack of seepage). (Cont'd on Plate M-6) [h:heath; R:reindeer moss; s:snow.]

SUBARCTIC MOUNTAINS

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SECURITY INFORMATION

PLATE
M - 6

ART III

Ground Photographs to Air Photographs A-12249-50, 51. Steep Slopes and Route to Pass.

KEEP WIDE MARGIN
TECH. REP. SIX



(Cont'd from Plate M-5) 5-9, 5-2: where the steeper slopes are covered by vegetation, the ascent is improved in this order: grassy slopes, better than uncovered, sliding talus; low bushes (heaths) better than grassy slopes. On Pl.M-5, 56-1 shows darker streaks where the heaths are invading. Such slopes could be ascended by jeeps up to the talus-slopes; they are essentially free of mud, even during the spring thaw.

DESCENT on a talus-slope (5-4, left of 5-1) can be rapid and convenient to the traveller without a pack, simply by running and sliding on the loose fragments. On the left of 5-1 can be seen an unstabilized shale talus slope [X] and a stabilized one overgrown with thin heath [Y], the latter by far the preferable route of ascent. [c:sedges and grasses; E:scrub birch; S:willow.]

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SUBARCTIC MOUNTAINS

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M - 7

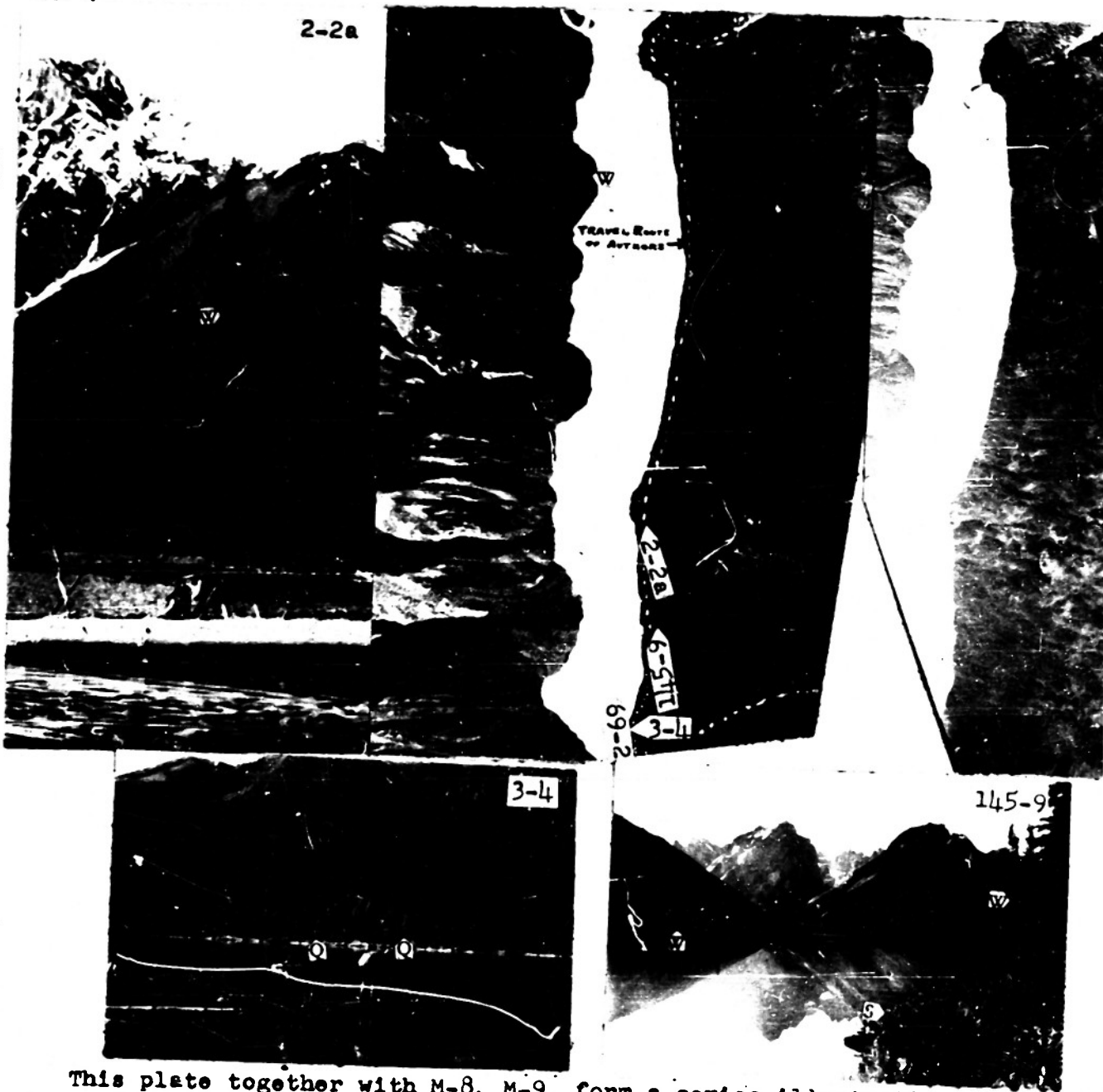
ART III

SECURITY INFORMATION

Glacier Lake, N.W.T., 62°N. 128°W. approx. Stereo Panchromatic Air Vertical Photographs, 1/20,000 approx. Roy. Canad. Air Force Southern Halves of A-12249-350, 351 (left). A Series of Hanging Valleys with Conspicuous Deltas.

TECH. REP. SIX

KEEP WIDE MARGIN



This plate together with M-8, M-9, form a series illustrating a common type of landform and its usually-accompanying type of vegetation in regions where glaciers have recently receded. On vertical photographs these are the readily recognizable fan-shaped deltas which are commonly well drained, gently sloping and covered in general with white spruce and willow immediately around the channels and forest margins. These deltas commonly afford the best available campsites despite a greater prevalence of mosquitoes, although not a breeding-place for these "devils of the North". [Q: a stand of aspen in an old burnt area; W: white spruce; S: willow.]

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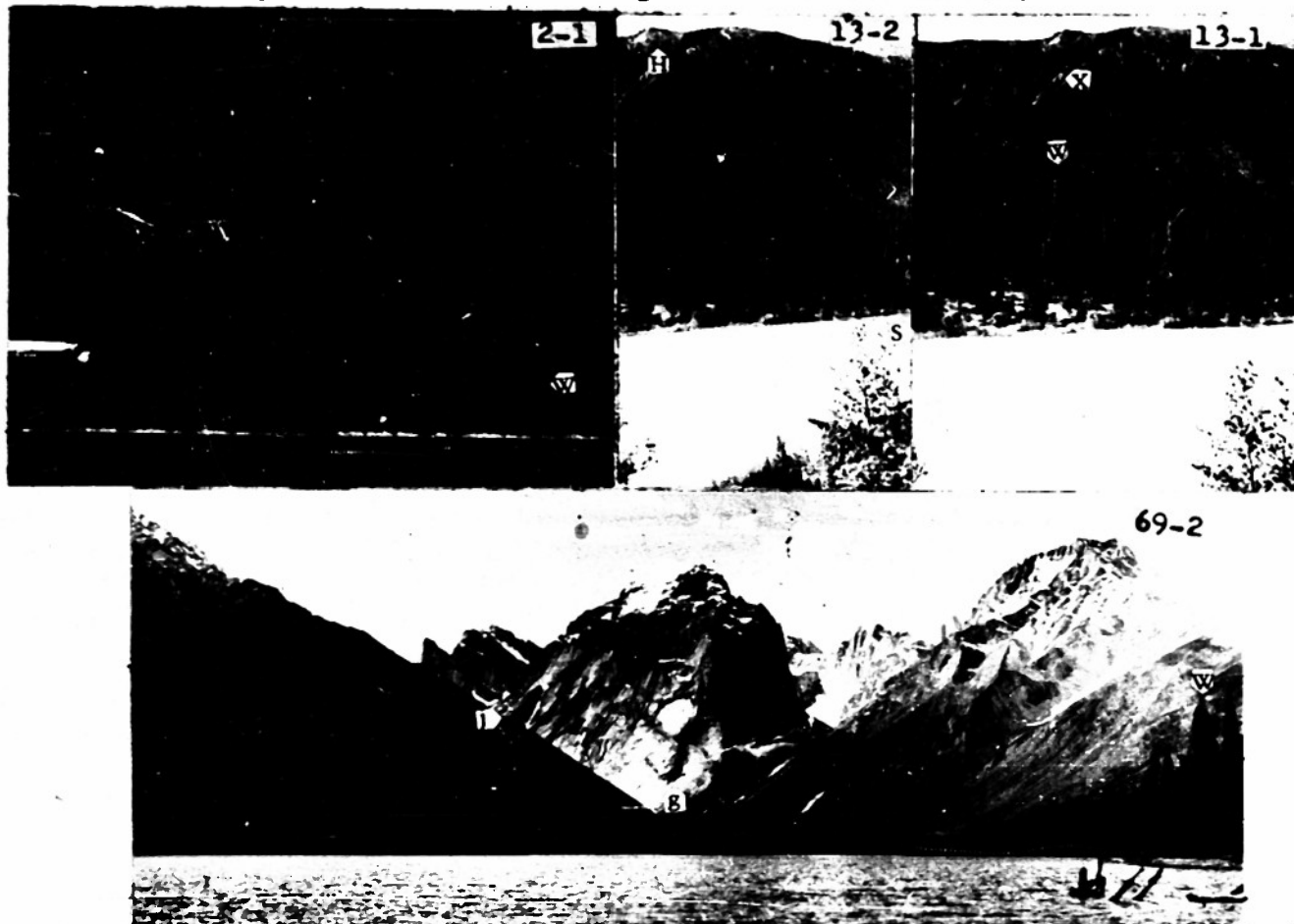
SUBARCTIC MOUNTAINS

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M - 8

RT III

SECURITY INFORMATION

Ground Photographs to Air Photographs A-12249-350, 351 and to A-12233-56, 57. White spruce the commonest vegetation on the deltas.



KEEP WIDE MARGIN
TECH. REP. SIX

Patterns of vegetation are shown in these photographs. The relatively dense white spruce forests occupy the delta-fans and the flatter parts of the banks. A thin stand of white spruce and willow bushes cover much of the slopes. In the "draws" the willows with some alders dominate, and cause these furrows to be the most obstructive of all lines of ascent. This close and invariable association of a type of vegetation (willow thicket) with a type of landform (gullies) as well as the association of the white spruce with the deltas is one of the most useful generalizations that a photo-interpreter can use on such photography. Attention is called here to the very great importance of using both land-forms and vegetative patterns in interpretation.

2-1 shows a horseshoe-shaped form at the right where two streams unite; a similar land-form-vegetation type is shown on the extreme left of 69-2.

Ground stereo pair (13-1,2) shows in the deep gully to the left, white areas, which are shale [X] outcrops (see also Pl.M-9,X), while at the top of the slopes there is a low growth of heath: this sums up the prevailing pattern on such slopes. The hydroplane can be noticed on the extreme left of 2-1 and in the center of 69-2, outlined on a rapidly exfoliating granite peak. [g:granite; H:heath; j:greyish shale; S:willow; W:white spruce.]

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SUBARCTIC MOUNTAINS

SECURITY INFORMATION

PLATE
M - 9

East end of Glacier Lake, N.W.T., 62°N.128°W. approx. Stereo Panchromatic Air Vertical Photographs, 1/20,000 approx. Roy.Canad.Air Force A-12233-56,57(right). Delta fans.



186-6, infra-red, shows an extreme contrast of cloud shadows and sun-lit areas in comparison with very much lesser contrast the panchromatic photograph(4-4) taken at nearly the same time and place. (They can be used as a strained hetero-stereo pair). The extremely light-toned vegetation on the slopes and in the valleys resembles snow at first glance.

(1) is the lower lake; E:scrub birch; m:milky glacial water; S:willow; W:white spruce; X:erosion gullies in shale.

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SECURITY INFORMATION

OT III

KEEP WIDE MARGIN
TECH. REP. SIX

Glacier at the Head of a Tributary of Dog-leg Creek, N.W.T., 62°N. 128°W. approx. Stereo Panchromatic Air Vertical Photographs, 1/20,000 approx. Roy. Canad. Air Force A-12278-208, 209 (left). Scant vegetation and terrain conditions at the foot of retreating glaciers.



KEEP WIDE MARGIN
-TECH. REF. SIX

On the highest parts of the mountains (here about 6000') vegetation is extremely scant, and of little use in photo-interpretation; another set of travel conditions prevails, identifiable by the different tones, textures and patterns: a) bare, nearly level, ice, affording easy, although slow walking; b) ice covered with snow, which makes walking slower and very hazardous without proper equipment; c) recently deposited moraine at 1) easier walking, due to better drainage and at 2) difficult walking due to poor drainage; d) bare granite and better walking; e) a well-drained medial moraine, affording good walking (Pl. M-26, M-27 for a similar medial moraine).

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RT III

SUBARCTIC MOUNTAINS

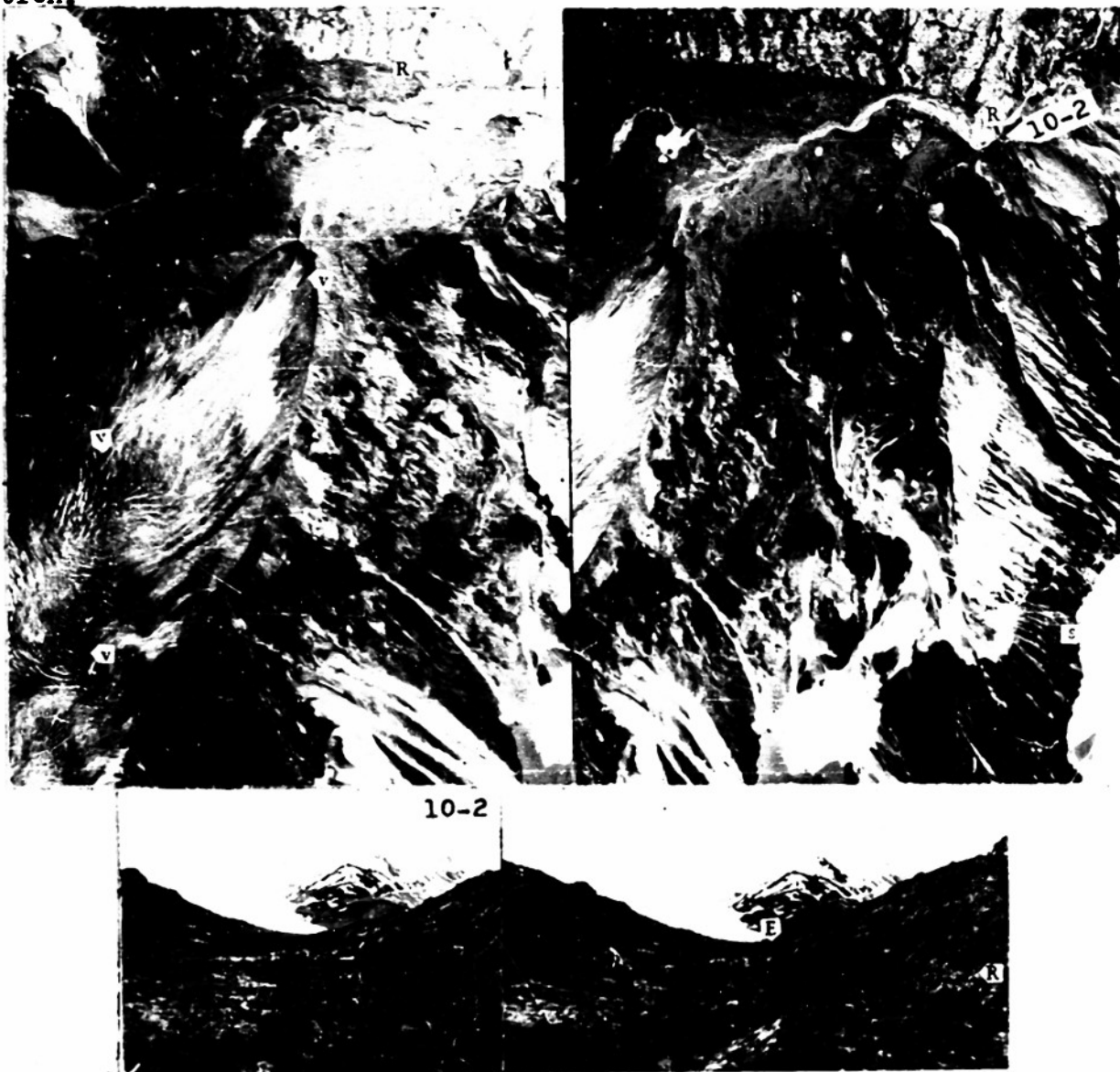
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PLATE
M - 11

Glacier and Moraine at Head of Dog-leg Creek, N.W.T., 62°N. 128°W. approx.
Stereo Panchromatic Air Vertical Photographs, 1/20,000 approx. Roy.
Canad. Air Force A-12278-205, 206 (right). Reindeer-moss and arctic vegetation.

KEEP WIDE MARGIN
TECH. REP. SIX



(In contravention of all stereo etiquette, the PI has not remained in the same spot; the terrain, however, is reasonably stationary.)

These pictures show terrain conditions similar to Plate M-10, except that at the top of the air-photographs there is an area of reindeer moss interspersed with darker rocks, where the walking is good when dry, but slippery when wet. Many of these rocks are covered with black lichens (occasionally used for food under survival conditions, although not recommended otherwise by this author).

(v) shows a heavily crevassed area in the glacier which must be avoided when using the glacier as a route. As a rule there are fewer wide crevasses and impassable ice-falls nearer the edges of glaciers. The whiter streaks show that the crevasses are partly snow-filled and hence doubly treacherous. [E: scrub birch; R: reindeer moss; s: snow].

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SUBARCTIC MOUNTAINS

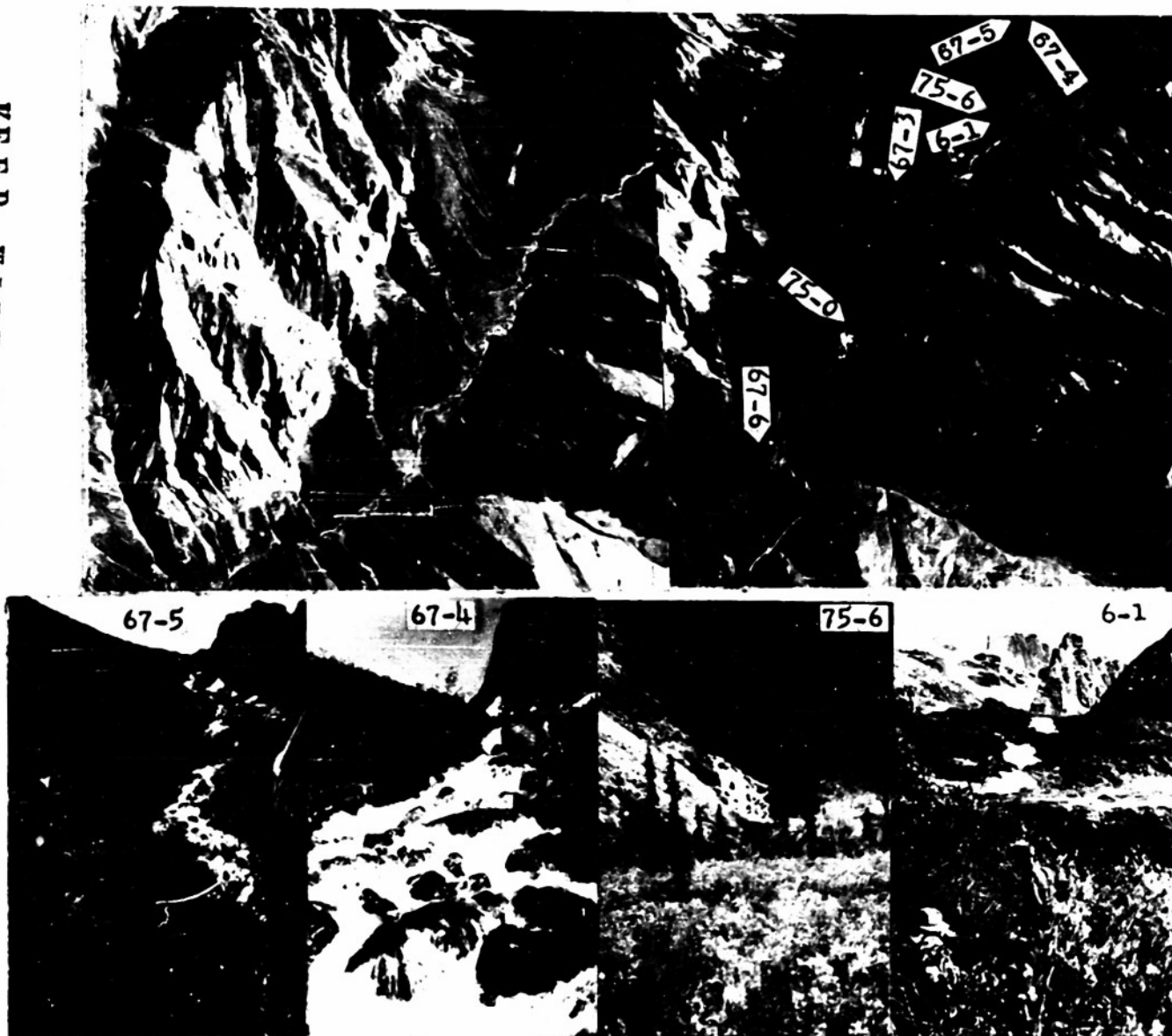
RESTRICTEDP L A T E
M - 12

T I I I

SECURITY INFORMATION

Martyn Creek near the Junction with Thomas Creek, N.W.T., 62°N.128°W. approx. Stereo Panchromatic Air Vertical Photographs, 1/20,000 approx. Roy.Canad.Air Force Southern Part of A-12237-71,72(left). Tree-line and "bush-line" of willow thickets.

KEEP WIDE MARGIN



The air photos show the marked timber line of white spruce on the east(left) bank of the stream; above the spruce the darker gray tone indicates scrub birch-heaths; the white rock is limestone. Above the spruce line and for some distance below it the banks of this stream are obstructed by almost impenetrable willow thickets (67-3, on Pl.M-13; 67-5 on M-12). The rushing waters of this small stream make its crossing hazardous (67-4, 67-5). The stream (potential breeding place of black flies) torrent is fed by melting glacier and snow banks higher up. The commonly associated willow thickets, dense and tangled on the banks make travel very slow and arduous (see next Plate). 75-6 shows the same willow thicket, a practically pure stand, near timber-line. Across the draw a milky glacial torrent gushes from beneath a

(See next Plate)

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SUBARCTIC MOUNTAINS

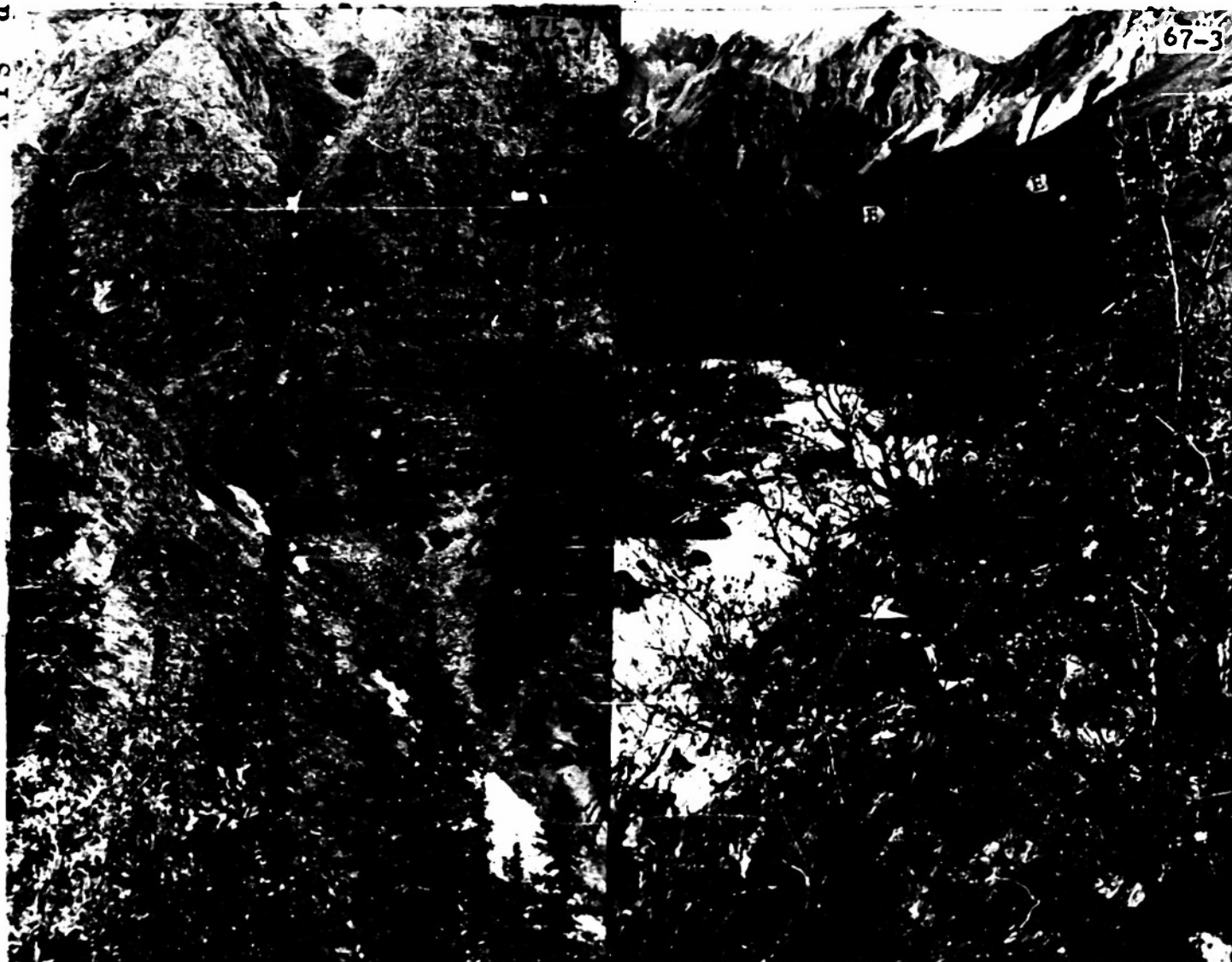
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SECURITY INFORMATION

PLATE
M - 13

PART III

Ground Photographs to Air Photographs A-12237-71,72. Showing extremely rapid erosion and dense willow thicket.



(Continued from Plate M-12)
large moraine (see Pl. M-14, 75-4). On the hillside above, scrub birch has covered the shale talus except along one long "rock chute" at the right of the picture. 6-1 shows again the dense willow in the foreground. The middle ground shows a thin heath and patches of snow. The peak in the background is granite. 75-9 shows a typically deeply eroded gully cut into the limestone. Scrub birch and thin heaths can gain only a precarious foothold; the sides of such gullies are by and large, too steep for travel. This picture was taken looking in the opposite direction from 75-0 on Pl. 14. 67-3 shows the continuous stretches of dense willow along the flanks of this stream. Scrub birch occupies the slopes above this[E]. (See also 67-5 on Pl. M-12.)

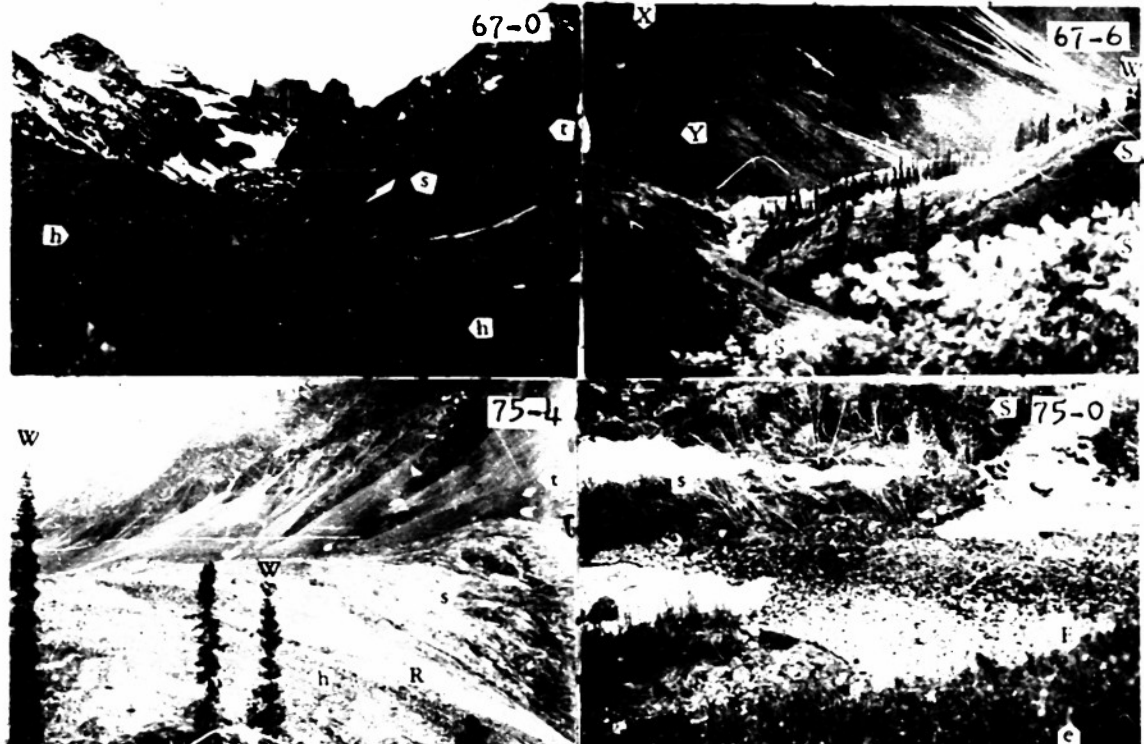
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SECURITY INFORMATION

T III

Ground Photographs to Air Photographs A-12237-71, 72. Showing snow bridge, talus and heaths.

KEEP WIDE MARGIN
TECH. REP. SIX



These four pictures were all taken within a distance of 1/4 mile of each other, along the same stream, all close to the tree line.

67-0 shows a high dry heath [h] in the foreground and a terminal moraine in the center middleground, from which the glacier has recently receded, essentially devoid of any vegetation. The dark, right-hand side of the picture shows shale talus slopes [t] with snowbanks [s] and a lower moraine (also shown on 75-4) thinly covered with vegetation, mostly reindeer moss [R]. This photo, as well as 75-4, was taken from approximately the same place and in the same direction as 6-1 on Pl. M-12. 75-4 is a detail at the lower moraine just mentioned, showing plainly the pure white patches of snow [s], the light gray patches of reindeer moss [R], and the darker areas of heath [h] in the lower right corner. In the foreground the commonest local variety of white spruce [W] is shown with typical slender crown. Since the very large talus slopes [t], evident on the mountain-side, are essentially free of vegetation, the PI can deduce that they are not stabilized and slide readily underfoot. 67-6, while appearing hazy, shows excellent detail under the lens, particularly the masses of light-toned willows [S] and dark-toned spruce [W]. In the background, the unstabilized talus [X] is seen as a lighter gray tone than the darker-toned scrub-birch [Y] heath-covered talus [Y] which affords better conditions for ascent than [X]. Typical light-toned willow bush in immediate foreground. 75-0 shows a permanent dark rubble-covered snow bridge, over 5' thick at the center, an excellent means of crossing such rapid streams. Such bridges, occasionally encountered on north-flowing streams are usually quite safe to walk on. There were three such bridges within a mile of each other on this stream. In the background are willows [S]; in the foreground, scrub-birch [E]. [s] is a clean snowbank. Again it may be well to emphasize the almost entire absence of mud in such areas.

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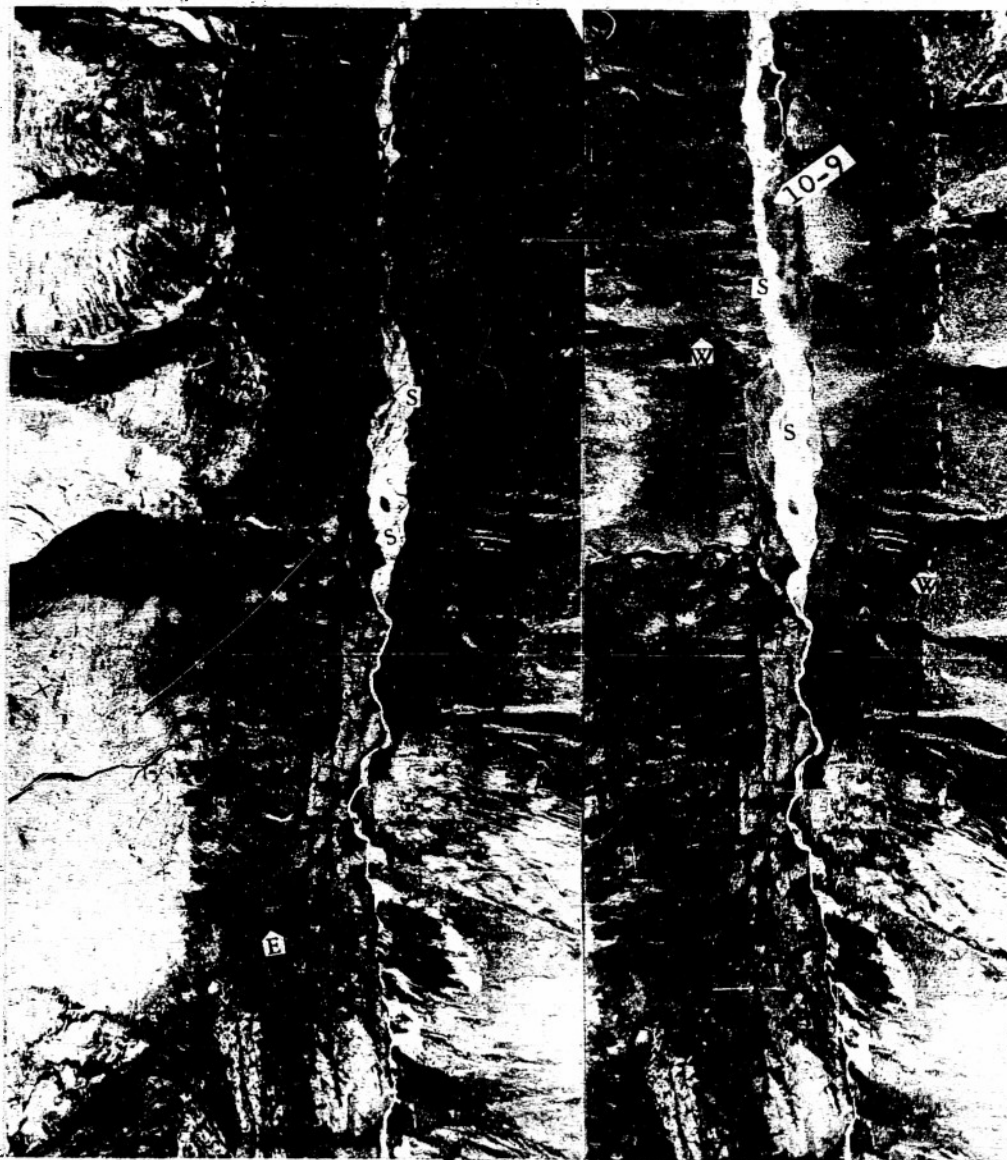
ART III

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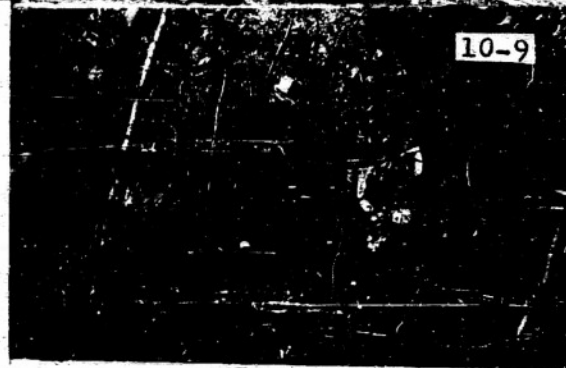
M - 15

Dog-leg Creek, N.W.T., 62°N.128°W. approx. Stereo Panchromatic Air Vertical Photographs, 1/20,000 approx. Roy. Canad. Air Force A-12-270-123, 124(left). Tree lines in U-shaped Glaciated Valley.

KEEP WIDE MARGIN
TECH. REP. SIX



The tree-line in the U-shaped glaciated valley is shown in this stereo-pair. The straightness of this valley and the right-angled trend of the tributary valleys suggest structural control(faulting?). Dark-toned areas: white spruce[W];gray areas near river: willows[S];gray areas higher up:scrub-birch[E]. Willow thickets along river make travel difficult (10-9). The braided section of stream affords easier walking except where it is necessary to cross the stream(see P.M-4).



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SECURITY INFORMATION

T III

SECURITY INFORMATION

Junction of Martyn and Thomas Creeks, N.W.T., 62°N.128°W. approx.
Stereo Panchromatic Air Vertical Photographs, 1/20,000 approx. Roy.
Canad. Air Force Northern Part of A-12237-71, 72 (left). White spruce
stands.

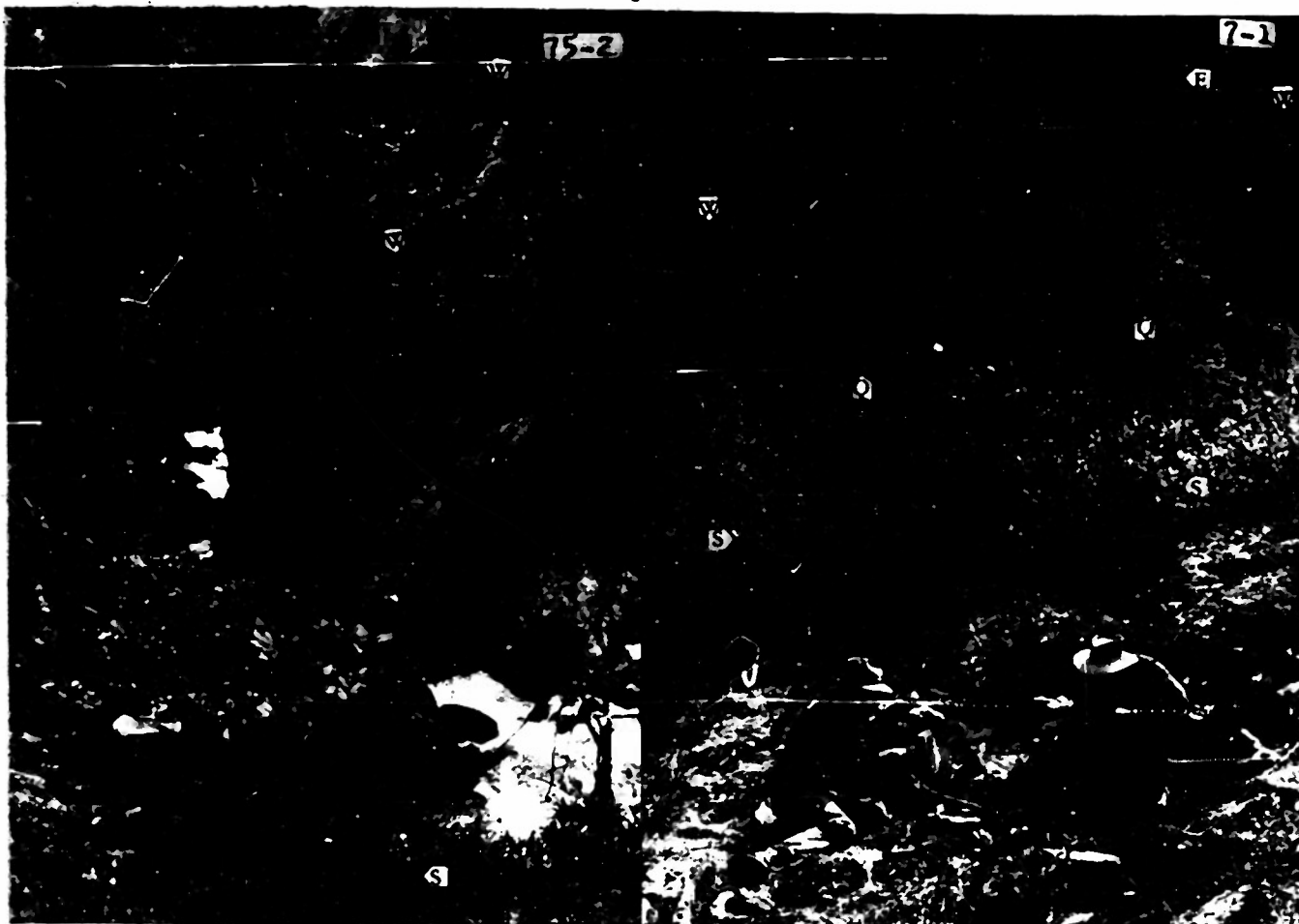
KEEP WIDE MARGIN
TECH. REP. SIX



75-8 shows a patch of willow[S] a considerable distance below the tree line. This mixture is not unusual at such elevations or in such terrain and is often a continuous obstacle to the traveler. In the background are talus slopes thinly overgrown with grasses and scrub-birch. The gully is partly filled with snow[s]. White spruce[W] has climbed higher on the talus than the willow, not uncommon in such areas. 75-7 illustrates crossing a typical glacial stream. In contrast to upper reaches of many such streams the mouths are often flatter and wider, making a crossing easier. 1 mile up stream(Pl.M-17, 75-2) crossing is impossible. This is a consistent enough generalization to be of value to the PI in determining best travel routes. In the background willows[S], typical vegetation of the gravelly flats often found along recently glaciated streams. Such flats afford good travel conditions. 8-4 illustrates another way of crossing fast streams, trees felled by the traveler(Pl.M-18, 115-9). On larger streams this practice is impossible(Pl.M-4, 107-1). In the background: a dense stand of white spruce.

ART III

Ground Photographs to Air Photographs A-12237-71,72. Extreme contrast on Tone of willows and white spruce.



75-2: often on such small streams deep, impassable canyons, such as this one, are encountered. It is usually necessary to climb above such gorges. In the foreground is a heath which is being invaded by willow [S]. On the opposite bank a few stunted white spruce [W] are shown. The lighter-toned areas are all bare rock outcrops.

7-1: a typical open "meadow", well below tree-line, surrounded by light-toned willow [S] and aspen [Q]; and in the background by dark-toned white spruce [W]. The dark grey slopes in the right background are covered with scrub-birch [E]. The foreground is covered with a low heath-like growth, which affords excellent walking conditions.

This photograph shows particularly well the great difference between the light-toned willows [S] and quaking aspens [Q] and the dark-toned white spruce [W]. Zonation is also shown with a low grassland in the foreground, a willow-aspen thicket in the middleground, the spruces further back.

The milky water from melting glaciers is commonly not considered fit to drink; however, if one does not object to the grit, it appears not to be poisonous or deleterious.

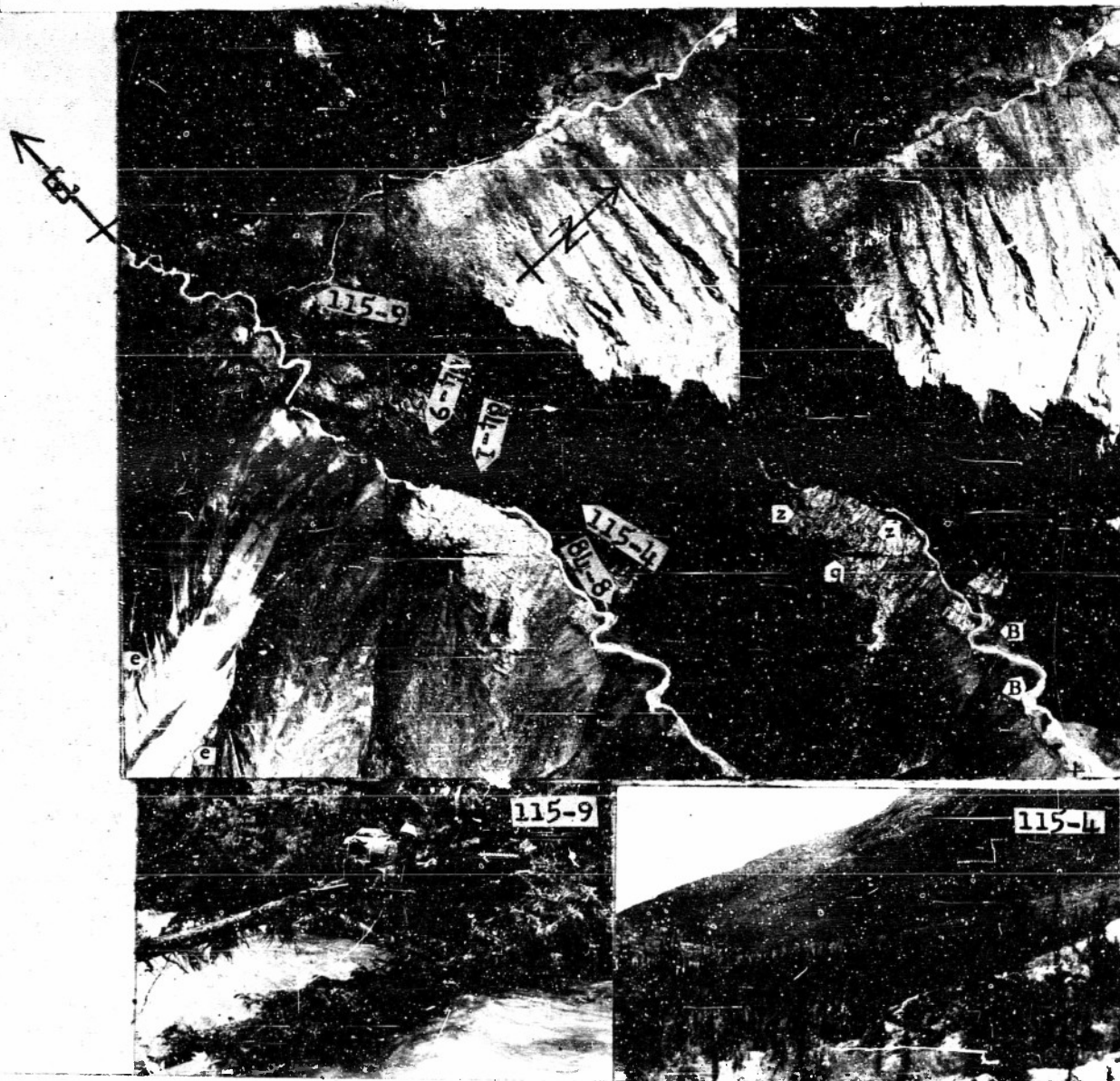
SUBARCTIC MOUNTAINS

RESTRICTEDP L A T E
M - 18

SECURITY INFORMATION

T III

Dog-leg Creek, N.W.T., 62°N. 128°W. approx. Stereo Panchromatic Air Vertical Photographs, 1/20,000 approx. Roy. Canad. Air Force A-12270-119, 120 (right). Reindeer-moss, outcrop of white quartz and tree line.

KEEP WIDE MARGIN
FROM TOP AND SIDES

This and the next two plates illustrates the rather close resemblance between certain white objects in this region and snow and ice. The white rivers in the air photos are not frozen; they are white from the rock flour in suspension in the water. The area [z] of light grey streaked with darker grey is coarse-grained granite (a pegmatite) largely covered with reindeer moss. Note that the rock-pool [q] is black and therefore is filled with clear water, not milky water. Erosion scars [e] are often conspicuously light-tinted. No snow shows on these air photographs.

The air photos show several examples of the constant association of a land feature with a type of vegetation; that is, the black spruce [B] and tamarack stands [plate M-19 (84-8)] (Cont'd on Plate M-20)

RESTRICTED

SECURITY INFORMATION

SUBARCTIC MOUNTAINS

RESTRICTED

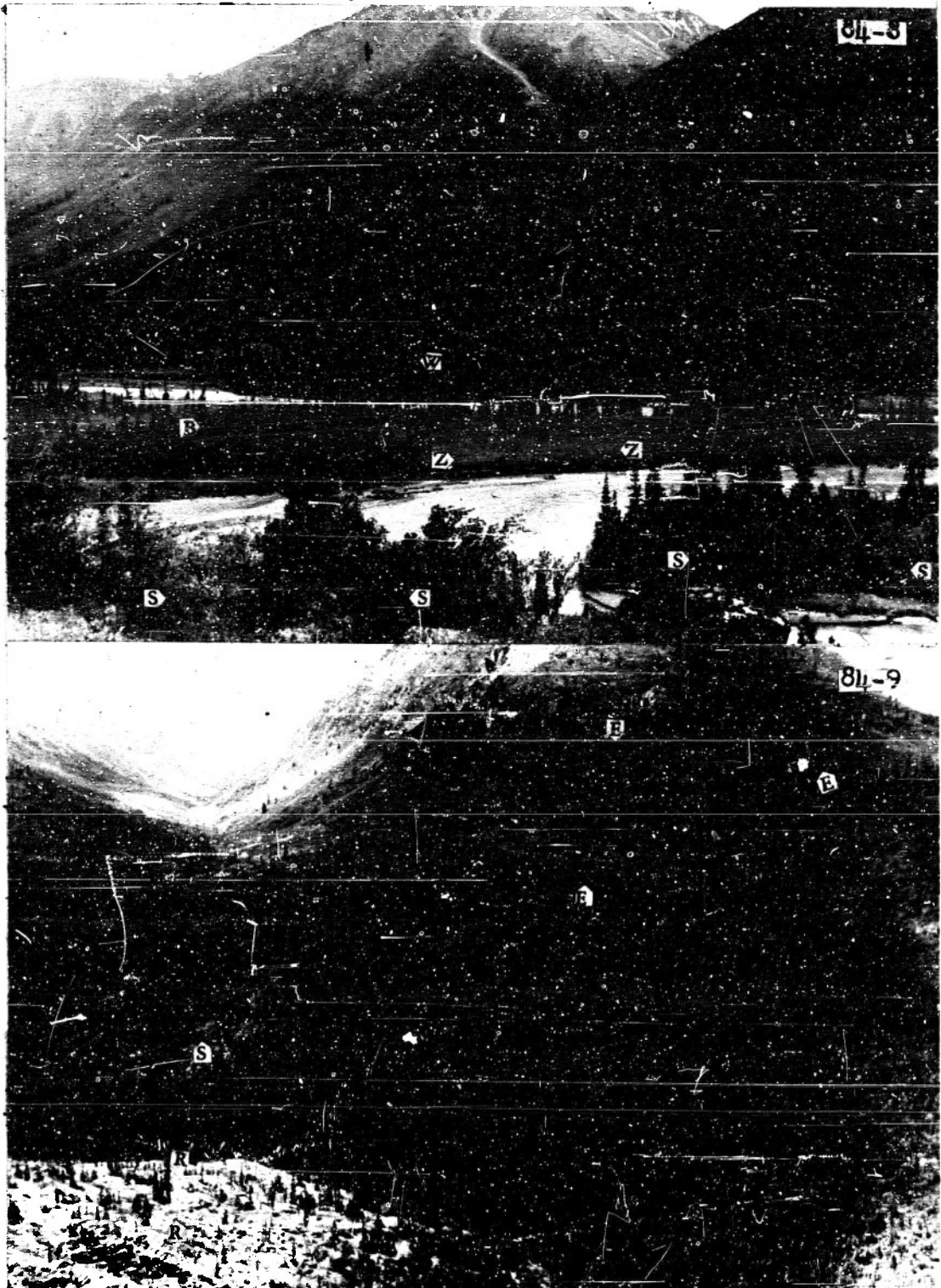
PLATE
M - 19

T III

SECURITY INFORMATION

Ground Photographs to Air Photographs A-12270-119, 120. Typical and prevailing thickets on sand and gravel bars. Dry ridge covered with shrubby birch.

TECH. REP. SIX
KEEP WIDE MARGIN



[B:black spruce; E:scrub-birch; R:reindeer moss; S:willow; W:white spruce; Z:marsh.]

RESTRICTED

ART III

SECURITY INFORMATION

Ground Photographs to Air Photographs A-12270-119,120. Reindeer moss covering outcrop of granite (pegmatite) and white rock flour in milky glacial stream.

(Cont'd from Pl.M-18) in permanently wet habitats which are either wet areas formed by the river meandering (ox-bows), or wet areas at the foot of the slopes where the water running off the steep mountainsides collects in considerable quantities, keeping such a locality permanently wet.

Although there are stretches of comparatively quiet water in these montane streams, they are usually rather short and the flow and depth of water in them is extremely variable according to season, weather, and even time of day; hence such streams can scarcely be included in any planned route of travel by boat or raft. On Dog-Leg Creek (shown here) the stream passes through a mile of unnavigable canyons only a short distance below this point.

The snow-like appearance of reindeer-moss when it covers much of the terrain is especially striking in sunlight. The pale tone of the willows [S], between the spruces [W] sometimes resembles hoar-frost or a light snow-cover. The milky water of the glacial stream sometimes simulates ice; but, as a matter of fact, there is no snow, ice, or frost showing on this picture.

Reindeer moss grows readily but slowly as a covering a few inches thick directly on outcrops of rocks as shown here [g:granite].

Note that the willows [S] are most abundant in the trough of the draw (the same shown on Pl.M-19(84-9)) and thus plainly indicate a poor travel route up the slope. By contrast the crest of the ridge on Pl.M-19(84-9) is relatively dry and covered largely with scrub birch, which on the lower half of the slope [E-1] is dense enough to obstruct travel considerably on such a steep slope, while on the upper half [E-2] the scrub birch is thinner and smaller and would permit much easier travel.

84-8 on Pl.M-19 shows a meandering river in a valley which somewhat resembles many of the smaller valleys in the drainage basin of the Tanana River in Alaska both as to topography and vegetation, e.g., the sand bars are overgrown with willows [S], while scattered white spruce is on the steep slope.

In general military movements in areas as this would be limited to foot soldiers; the vegetation below the tree line affords easy concealment almost anywhere, although little in the way of substantial cover. As a rule, the worse the travel conditions, the better the concealment.



TECH. REP. SIX

KEEP WIND HAND

SUBARCTIC MOUNTAINS

RESTRICTED

PLATE
M - 21

PART III

SECURITY INFORMATION

Junction of South Nahanni River and Dog-leg Creek, N.W.T., 62°N.123°W. approx. Stereo Panchromatic Air Vertical Photographs, 1/20,000 approx. Roy. Canad. Air Force A-12270-117, 118 (left). AFTER EFFECTS OF FOREST FIRES. Heaths, reindeer-moss and aspen-willow-birch thickets.



115-1



Areas swept by fire are sometimes said to be impossible of interpretation because the vegetation (particularly the forests) has been destroyed. This is an almost obvious error; the plants which appear after a burn indicate the type of terrain just as much as their predecessors.

The commonest tree invading a burned area is the quaking asp [Q], accompanied by scrub-birch [E] in the drier and willow [S] in the moister areas. [B: black spruce-larch bog; M: 1000 lbs. of emergency rations - fleeing hungry PI's (a moose); s: snow; t: shale talus; W: white spruce]

RESTRICTED

KEEP WIDE MARGINS
TECH. REP. SIX

ART III

Glacier Lake, N.W.T., 62°N.128°W. approx. Stereo Panchromatic Air Vertical Photographs, 1/20,000 approx. Roy.Canad.Air Force Northern Halves of A-12249-350, 351(left). An upland black spruce-tamarack bog.

KEEP WIDE MARGIN
TECH. REP. SIX



The "hetero-stereo" pair of ground photos (4-2, 186-3) on the next plate were taken from the crest of the ridge above the bog. [13-3, 13-4, Pl. M-24]. The infra-red photos (186-3) make the white spruces appear abnormally white. [W]:white spruce, [E]:scrub birch; [s]:snow. The mountain in the far background is granite; the others are shale and slate (See Pl.M-30)

Travel through this scrub birch near the tree-line is slow and arduous except on big-game trails which generally follow the crests of these ridges. To accomplish the first round-trip over this ridge with a heavy pack, the author needed 3 days; later, with the same pack, but with a foreknowledge of the game trails, only one day was needed for the same round trip.

On the above air photos the transition from white-spruce [W] forests to scrub-birch [E] is evident. Below in the upland bog, the grey streaks show areas of stagnant water [w]; [z] is a similar, larger area. (See Pl. M-24, 13-3,4)

Near the top of the air photos here the very light grey is reindeer moss [R], while the purer white are greyish shale outcrops [j]; the long, white "fingers" are dry draws filled with talus [t] of this same light-toned shale. These can be distinguished from snow[s] by the fact that the snow does not necessarily lie in accordance with the land-form (but rather in accordance with the direction of the slope: North-facing slopes hold snow longer than others - see Pl.M-14,75-0), while the talus is independent of compass direction

C PART III

SUBARCTIC MOUNTAINS

RESTRICTED

PLATE
M - 23

SECURITY INFORMATION

Hetero-sterio Pair of Ground Panchromatic and Infra-red Photographs to A-12249-350, 351. The upper photographs are singletons of the stereo-mounted pair. Tree line of white spruce transition-zone to shrubby birch.

KEEP WIDE MARGIN
TECH. REP. SIX



4-2



4-2

186-3



[E:shrub-birch, Q:asp, S:willow, s:snow, w:white spruce]

RESTRICTED

SECURITY INFORMATION

PART III

SUBARCTIC MOUNTAINS

RESTRICTED

PLATE
M - 23

SECURITY INFORMATION

Hetero-sterio Pair of Ground Panchromatic and Infra-red Photographs to A-12249-350, 351. The upper photographs are singletons of the stereo-mounted pair. Tree line of white spruce transition-zone to shrubby birch.

KEEP WIDE MARGIN
TECH. REF. SIX



[E:shrub-birch, Q:asp, S:willow, s:snow, W:white spruce]

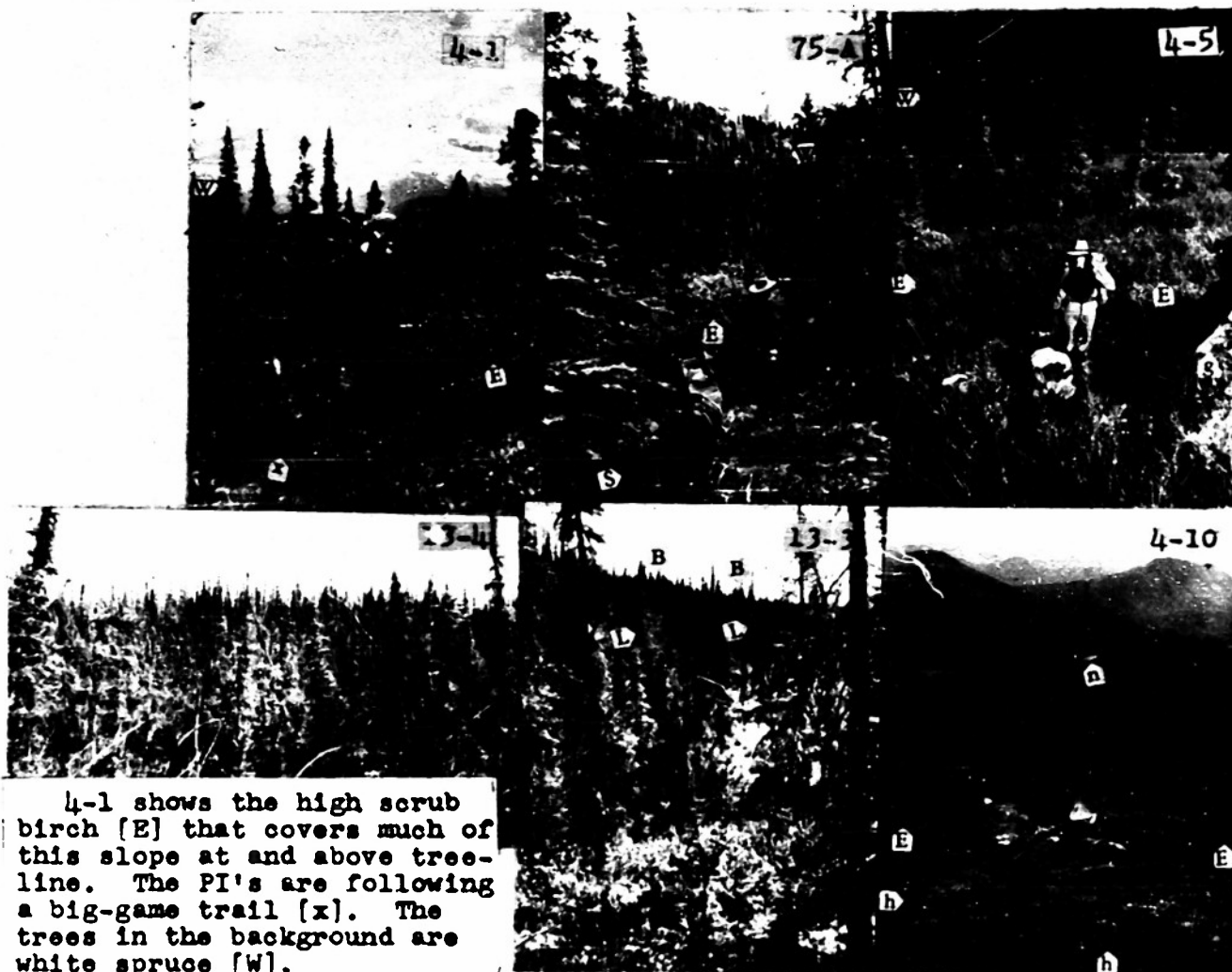
RESTRICTED

SECURITY INFORMATION

Ground Photographs to Air Photographs A-12249-350,351. Big game trail, tree-line, black spruce and larch (tamarack) bog and Arctic heaths on mountain top.

TECH. REP. SIX

KEEP WIDE MARGIN



4-1 shows the high scrub birch [E] that covers much of this slope at and above tree-line. The PI's are following a big-game trail [x]. The trees in the background are white spruce [W].

75-A: illustrates the same slope in 4-1 well below tree-line. The scrub-birch [E] are smaller and intermixed with willow [S]. The trees are white spruce [W]. Travel here is more obstructed than in 4-1. Both photos indicate relatively dry, well-drained terrain.

4-5: immediately above tree-line on this steep, dry, east-facing slope, the hillside is covered with a continuous, dense thicket of scrub birch [E]; the stalks of these bushes lie parallel to the ground, then curve upwards, making foot-travel doubly difficult. The trees are white spruce [W]; [g] is a granite boulder deposited by the past ice-cap on this shale mountain.

4-10 is the same dry slope as shown in 4-5 about 500' higher; here a heath-like cover [h] has largely supplanted the scrub birch [E]. [n] is the S. Nahanni River. Although steep, travel here is very open and generally easy.

13-3,4 is an upland black spruce [B] - larch [L] bog, stretching several miles on this plateau. These bogs, while slow and wet for travelling are not always deep enough to be a serious obstacle and are sometimes preferable to the denser, but drier surrounding terrain.

T III

SUBARCTIC MOUNTAINS

RESTRICTED

. P L A T E
M - 25

SECURITY INFORMATION

Glacier Lake Fed by Rapid River, N.W.T. 62°N. 128°W. approx. Stereo Panchromatic Air Vertical Photographs, 1/20,000 approx. Roy. Canad. Air Force A-12250-371, 372(right). Numerous beaver dams and crowfoot delta outlined by the white "glacial milk."



The air-photos show an unusually dense vegetation - so thick as to be a considerable obstruction to any type of travel.

The main channel of the river [m] is not a good travel route as it is necessary to cross and recross numerous channels of rapid water. An old channel [o] is now partly stagnant and swampy (particularly close to the left bank) and partly a tangle of willow and beaver dams. The white spruce [W] forests on the flats are so dense as to be practically impenetrable. The easiest route of travel here is directly through the beaver country and sloughs, which often involves wading waist deep in the water. In large braided streams like this, such dilemmas are common.

The long, mucky crow-foot delta extending into the lake is too soft and treacherous to permit travel. These deltas change their outline rapidly.

B-1 shows a drier and thinner white spruce forest. Travel here is excellent on a well-defined big-game trail: it is common along the larger streams for game trails to disappear in swampy or otherwise difficult terrain, and reappear later where terrain conditions are better. Game trails are more commonly found on the North banks of streams (left on these photos) since the snow will melt off this bank much sooner.

B-2 illustrates the scrub-birch-heaths [E] common above tree-line.

At the bottom of air-photo the very white area is a large granite outcrop, not snow or ice.

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SUBARCTIC MOUNTAINS

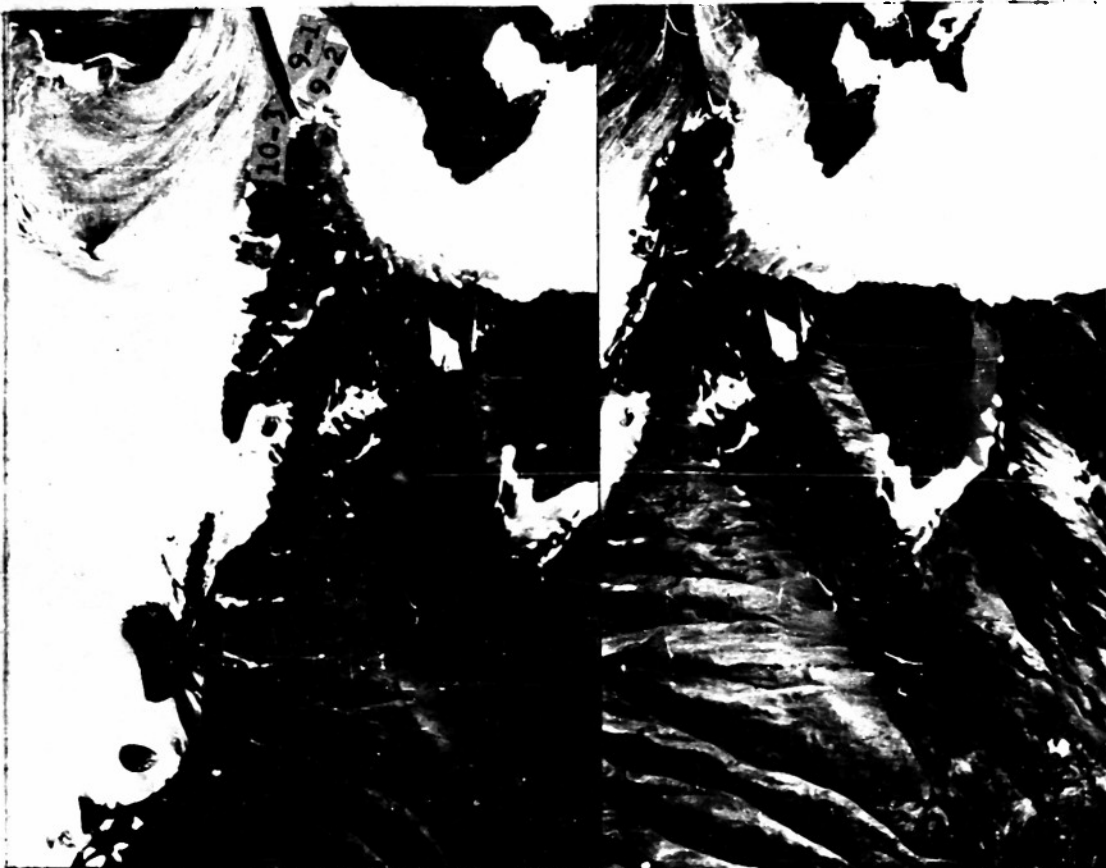
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PLATE
M - 26

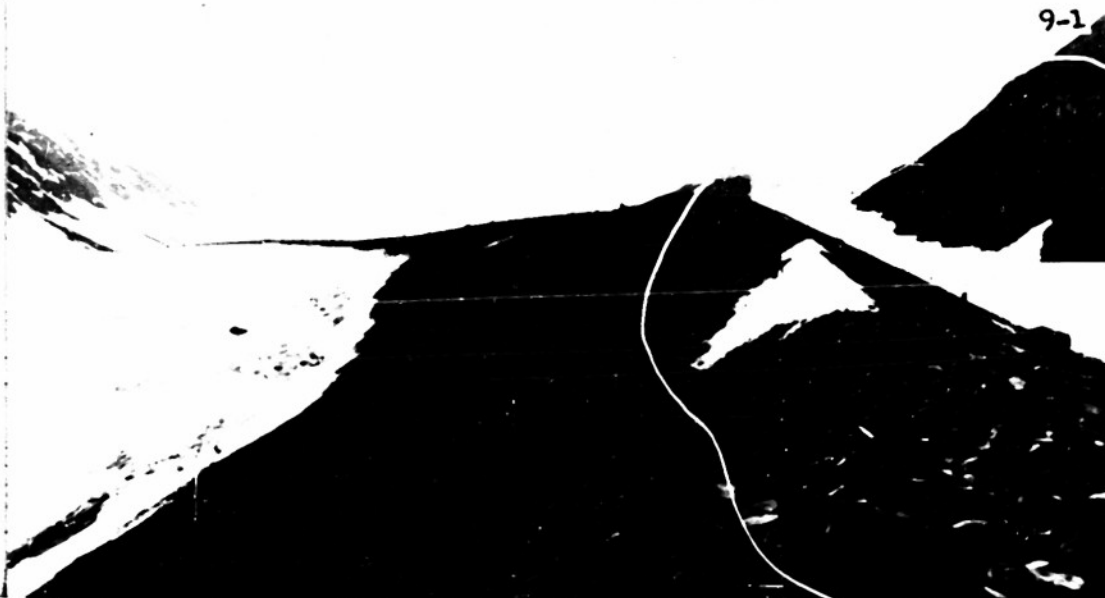
ART III

SECURITY INFORMATION

Divide between Thomas and Dog-leg Creeks, N.W.T., 62°N. 128°W. approx
Stereo Panchromatic Air Vertical Photographs, 1/20,000 approx. Roy.
Canad. Air Force A-12278-206, 207(left). Medial moraine, by far the
best travel route for man. Much used by grizzly bears and caribou.



KEEP WIDE MARGIN
TECH. REP. SIX



9-1

Following plate shows additional ground photos and discusses the aerial
photos.

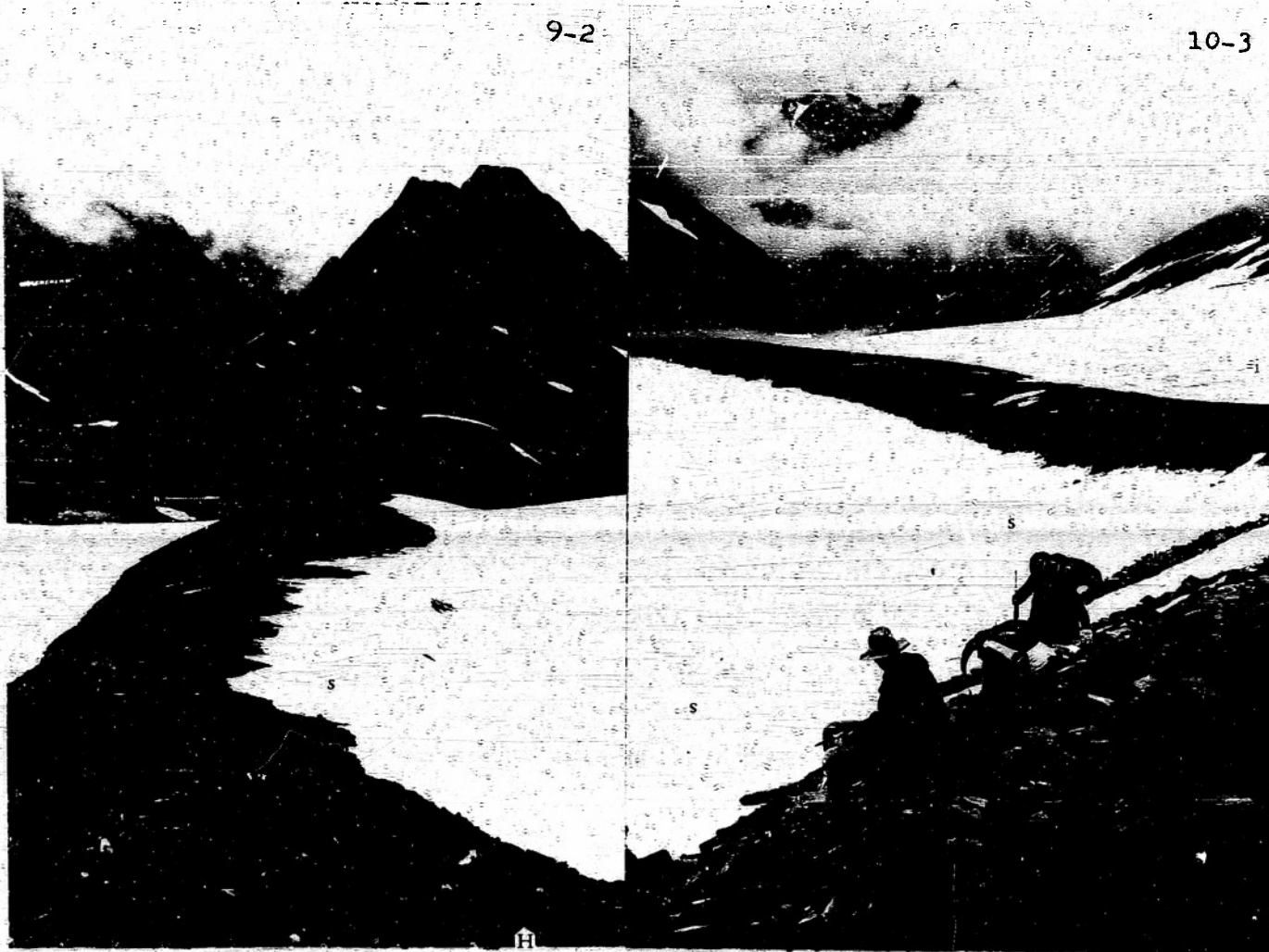
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ART. III

Ground Photographs to Air Photographs A-12278-206,207. Medial moraine, the best route of travel.

9-2

10-3



When without proper equipment for safe travel over glaciers or ice-fields, the traveller is often forced to avoid them and to follow the safer although usually more arduous and circuitous talus and moraines. Occasionally, however, a moraine (in this case a medial moraine; that is, one between two glaciers or two parts of one) will afford a good route along or past a glacier. The one shown in this series of photographs was so convenient that big-game commonly used it as a route. Any route followed by big-game, whether above or below tree-line, is almost universally also the best route for man.

Although ascending the flanks of such moraines is usually difficult on account of the steepness and softness, the top is firm enough so that a small vehicle could be driven along it. All the rock in these photos is shale, actually facilitating travel here; if the rock was granitic, the moraines would be composed of much larger boulders which would constitute a definite impediment to travel.

At such elevations the vegetation is very scant and of little use in photo-interpretation. [H:thin heaths; i:bare glacier ice; s:snow] CONTRAST IN TONE AND TEXTURE BETWEEN BARE ICE AND ICE COVERED BY SNOW ON ONE AND THE SAME PHOTOGRAPH /

RESTRICTED

SECURITY INFORMATION

CH-REP-SIX

KEEP WIDE MARGIN

RESTRICTED**SECURITY INFORMATION**

Near the North and South Forks of the South Nahanni River, N.W.T.,
62°E. 127°W. approx. Stereo Panchromatic Air Vertical Photographs,
1/20,000 approx. Roy. Canad. Air Force A-12250-363, 364 (right).
Showing Game Trails, the Best Routes of Travel.

KEEP WIDE MARGIN



Game trails are very commonly the best routes for foot travel in most of this territory. [Z] shows an excellent big-game trail which extends for over a hundred miles along this river.

As always (see Pl. M-25) game trails are usually found on the south-facing banks of rivers; only where terrain conditions prevent this, do the trails appear on north-facing banks. The trails along larger rivers, as the one here, are commonly 4 to 5 feet wide, presenting the traveller by far the best local route to follow.

12-4: a calmer stretch in the river. Here the banks are well-defined as shown by the white spruce [W] found growing at the water's edge. Note the dense tangle of willow [S] on the lower right.

12-6,5: this stereo pair illustrates the same condition as in 12-4, except that across the river the willows [S] and quaking aspen [Q] indicate a vegetation obstructive to the traveller. The peaks in the background are granite, rising over 6000' above the river level, forming an impassable barrier.

RESTRICTED

SECURITY INFORMATION

PART III

Travel and terrain conditions on sandy gravel bars and islands in braided river such as shown on Air Photographs A-12250-363, 364.

12-B



12-A



Vegetation is commonly an excellent indicator of travel conditions along the banks of streams and rivers in such mountainous regions. The streams and rivers themselves are also indicators of travel conditions. They are of limited use for transportation, and they may be put in two classes according to whether or not they can carry the eroded material. Shown here is a river which is evidently overburdened: i.e., a braided stream. Such a stream rapidly fills up its channels and moves to and fro in its bed and, in fact, its whole valley is continually subject to rapid changes. This is reflected in the vegetation, which is mostly plants (largely willows [S]) which invade quickly. Older, better-established vegetation, as white spruce [W]-forests, appear only on more stable banks.

RESTRICTEDKEEP WIDE MARGIN
TECH. REP. SIX

C PART III

Ground Photographs near the source of Thomas River. Travel and terrain conditions, about one-half mile (9-3) and two miles East (8-3) of Air Photograph A-12278-206,207.

8-3



9-3



Photograph 8-3 illustrates the influence of the parent rock on travel conditions; here a talus of granitic blocks makes travel poor and even treacherous when the black rock tripe (lichens) on the rock are wet. If this slope had been shale-covered, travel would have been easier.

9-3 shows a route leading up a snow-filled canyon. Where such canyons are completely filled with snow they afford good routes of travel. When they contain an insufficient quantity of snow to support a man's weight, of course, they become hazardous to say the least as there is usually, as here, a rushing torrent beneath the snow.

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Part III

R E S T R I C T E D
Security Information

TERRAIN CONDITIONS
IN A PEAT-CUTTING AREA
IN THE
SUBARCTIC SPRUCE-FIR FOREST
DEDUCIBLE FROM AIR PHOTOGRAPHS.

Test Location:

(Rather typical of peat-cutting districts
in Ireland, Germany, USSR, etc.)

South Shore of St. Lawrence River

at

Pointe-au-Père, Rimouski, Province of Quebec.

Elevation:

Sea level to 35 feet.

Illustrated by

Peat - Series of Plates.

Ground Photographs and Field Notes

by

Ernest Lepage

Nov. 1952.

R E S T R I C T E D
Security Information

TERRAIN CONDITIONS IN PEAT AREAS
IN THE ARCTIC AND SUBARCTIC.

The military significance of peat bogs can hardly be overestimated. Their terrain conditions are profoundly affected by the season of the year, the type of vegetation covering the bog and the industrial activities in and around the bogs. Immense areas are covered by peat bogs (i.e. muskegs) in Canada and Alaska, in the British Isles, Scandinavia, in the Baltic Areas, in Poland, etc. Tactics and strategy in such areas will necessarily be conditioned by these bogs. The result of many of the world's battles and whole campaigns have been largely influenced by the way in which these peculiar terrain conditions have been understood and used or disastrously ignored. Napoleon's as well as Hitler's march toward Moscow, Tannenburg, the Mazurian Lakes and the Pripet Marches will recall the truth of this statement. Accordingly for a rapid rough interpretation, rules for interpreting terrain conditions in peat bogs are stated here as follows:

1. In general, when DEEPLY frozen, such bogs are readily crossed even by heavy vehicles.
2. In times of thaw or shallow freezing, they offer only treacherous and unpredictable "trafficability".
3. When covered with deep snow, they are excellent travel routes on snowshoes.
4. The presence of game trails on photographs of bogs

can be taken as evidence that the bog is frozen solid. Such trails make easier travelling for the foot soldier if he does not have snow-shoes. They are not used for snow-shoe travel.

5. Frozen peat bogs are unsuitable for crossing by means of horse-drawn sledges, because the ice does not form in an even sheet, as on a lake, but in hummock-like formations and /or in layers through which the horse would easily break.

6. Light cabin tractors (e.g. Bombardier commonly used in Canada) carrying twenty men, can cross a frozen bog readily. In Canadian rural districts, this method of cross-country travel is used for many purposes, e.g. transportation of school children, the village doctor, etc. During the last World War such tractors were exported to Russia.

7. The photo-interpreter should practice recognizing what type of vegetation covers the peat-bog in summer. IF VERY LIGHT-TONED, it is probably surfaced with peat-moss or sedges and can be crossed by foot soldiers wearing snow-shoes IN SUMMER. If the bog is medium gray-toned, as on average prints, and stereo effect indicates bushes, such as heaths, it is unsuitable for snow-shoe traffic in summer.

8. In general, peat bogs IN SUMMER are much more impassible than water for vehicles of any type except those specially built for this purpose.

9. If ditches, where peat has been cut, are recognizable on the photograph, those which are dark contain water; those

that are light-toned afford firm footing.

10. If a military road is to be built, firm footing can be expected after removal of all the peat.

11. Peat that has dried during the summer is a source of fuel. It can be used to built well-insulated sod houses or temporary shelters. It is good material to use in place of sand bags for the parapet of a trench.

12. On very flat areas, it is of importance to locate roads where the peat layer is shallowest. This can be done by use of the vegetation as an indicator. Low bushes and peat moss indicate the deeper layer, trees the shallower layer.

Referring to Plate "Peat 1", the outline of the lake which was filled by the formation of peat is evident both from the stereo-effect and the concentric zones of vegetation. Notice also the successive river terraces. On the lowest terrace near the river (ALWAYS THE BEST TERRAIN FOR TRAVEL) a road has been built clearly demonstrating this point. The second terrace is characteristically outlined by the row of dark-toned alders (A1), which also shows the presence of a seepage and a water-table close to the surface. The second terrace in a series of river terraces never offers as good travel conditions as the first or lowest terrace on the river bank. The highest river terrace near the foot of a mountain is usually badly water-logged. Plate Peat-3 shows trees (W) indicating a shallow layer, and bushes (P) indicating a deep layer of peat.

REP. SIX
PART III

RESTRICTED

PLATE
PEAT -1

SECURITY INFORMATION

Peat-cutting Area, South Shore of the St. Lawrence River, Rimouski. Panoramic Vertical Air Photographs, 1/15,840 reduced to approx. 1/17,000. Roy. Can. Air Force A 12956-131, 130(right). A: alders; B: canoe birch; C: cottonwood; K: lambkill; Q: aspen; W: white spruce; L: larch; g: grass; h: leather-leaf; 1: lower pit; 2: higher level pit; 3: clay on a tidal flat; 4: pools in brackish mar



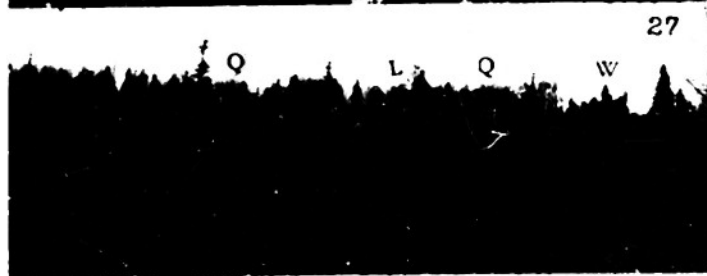
KEEP WIDE MARGIN

RESTRICTED

SECURITY INFORMATION

Ground photographs of peat-cutting area indicated on air photographs on the preceding plate. The regularity of the straight-lines of such workings makes them recognizable on photography of Ireland, Germany, USSR and other countries of the Old World. Nov.-Dec. 1952.

Peat, the remains of dead plants, in many parts of the subarctic region of the world forms layers of fragrant-burning fuel, several to many feet thick. It is formed under stagnant shallow-water overlying an impervious layer of clay, hard-pan or rock. Such a layer of dead plants has considerable influence on the layer of living plants above it, in fact, the type of vegetation and terrain called "muskeg" (an Algonquian word meaning "mud" or a "wet place" according to James Geary) has been defined by Dachnowski-Stokes as an "area overlying peat." A short time before Dachnowski, our leading peat-specialist died, he told the author, he could not define "muskeg" any more precisely than this. 27 is an example of "muskeg" or peat-bog showing in the background a zone of trees i.e. larches (L) and white spruce (W). Where trees grow can be taken as an indication that the peat is not more a few feet deep (rarely more than 3'). Notice that the road was built in the tree zone. 28 shows a detail of the central or treeless zone, where there are no trees but only bushes. The bushes are mostly of 2 kinds and belong to the heath family, hence, the word heath or heather, often applied to peat bogs (h is leather-leaf; K is lamb-kill). These bushes indicate a deep layer of soft peat. Such a bog is a formidable almost impassible military obstacle. Horses sink to their bellies; man to his waist. Tracked vehicles soon bury themselves in it. The depth of the soft peat may be estimated as inversely proportional to the depth of the tone of gray on the photograph, i.e. driest darkest outer zone is mostly white spruce, the less dark zone has a fair amount of larch, the tree-less, light gray central zone indicates the deep layer. When all the peat has been removed, the trench (30) remaining has a firm bottom and can be used as a route for making a road unless the area is so low-lying that water cannot drain out of it. Note on the preceding plate the dry ditches suitable for roads are nearly white while the wet ditches (used for drainage) filled with water are black.



Q: Aspen.

REF ID: A111
PART III

RESTRICTED

SECURITY INFORMATION

PLATE
PEAT - 3

An Unsuit Area of Peat, deep at(P) under bushes, and shallow under trees(W). Roy. Canad. Air Force A 12956-7,8. Adjacent to area on Plate Peat-1. Al: alders; L:larch; q: outcrops of pale rock(quartzite); T:cedar; W:white spruce.

KEEP WIDE MARGIN



RESTRICTED

SECURITY INFORMATION

SET OF TWENTY SUPERPOSABLE

MAPS OF USSR

ALL CONIC PROJECTIONS

ALL ON SCALE OF 33,500,000.

Adapted by

Arthur Barwick

As a Source of Information

To Help in Deducing

Terrain Conditions

from

Air and Ground Photographs.

R E S T R I C T E D
Security Information

Tech. Rep. 6
Part III

INDEX
to
TWENTY SUPERPOSABLE MAPS OF USSR.

Conic Projection

Scale 1: 33,500,000 reduced in photographing from 1: 32,000,000

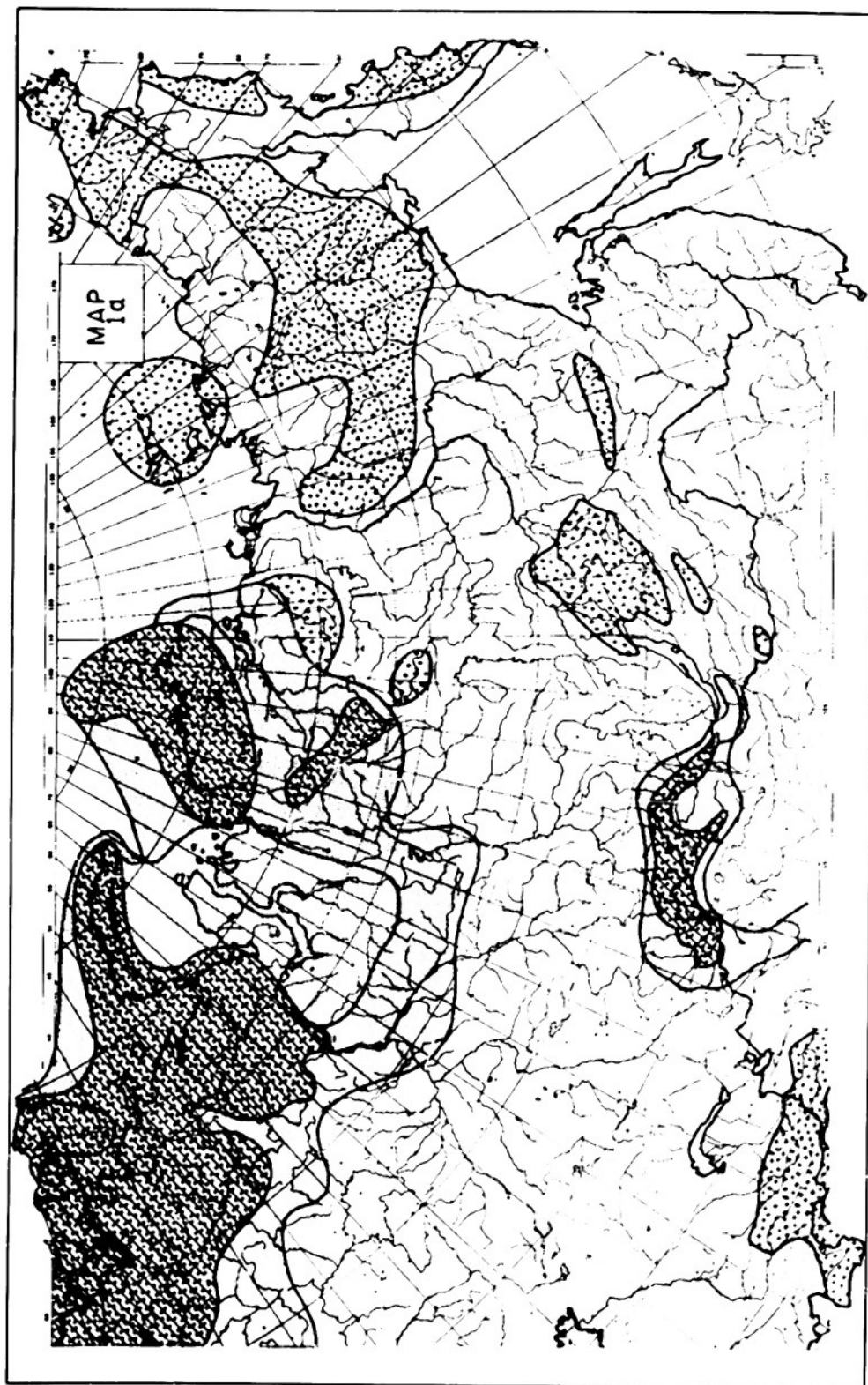
adapted by

Arthur Barwick

- 1a. Glacial Map of U.S.S.R.
- 1b. Tectonic - Geological Zones.
2. Mean July Temperature (Sea-Level) C°.
3. Mean January Temperature (Sea-Level) C°.
4. Mean Annual Precipitation - inches.
5. Extremes of Seasonal Precipitation - inches.
6. Duration of Snow in Days.
7. Depth of Snow in Centimeters.
8. Permafrost Zones of U.S.S.R.
9. Soil Map of U.S.S.R.
10. Natural Zones of U.S.S.R. (After Berg).
11. Tree Limits in European Russia, Stone Pine, Alder, Beech.
12. Tree Limits in European Russia, Oak, Linden.
13. Tree Limits in European Russia, Norway Maple, Ash, Hornbeam.
14. Tree Limits in European Russia, Ash, Beech, Hornbeam, Linden,
Maple, Oak.
15. Percentage of Total Land Cultivated, U.S.S.R. (After Balzak).
16. Tree Limits - Siberia. Dahurian and Siberian Larch.
17. Tree Limits - Siberia. Siberian Fir and Siberian Larch,
and Dahurian Larch.
18. Tree Limits - Siberia. Scotch Pine (Fir), Norway Spruce.
19. Tree Limits - Siberia. Linden, Siberian and Japanese
Stone Pines.

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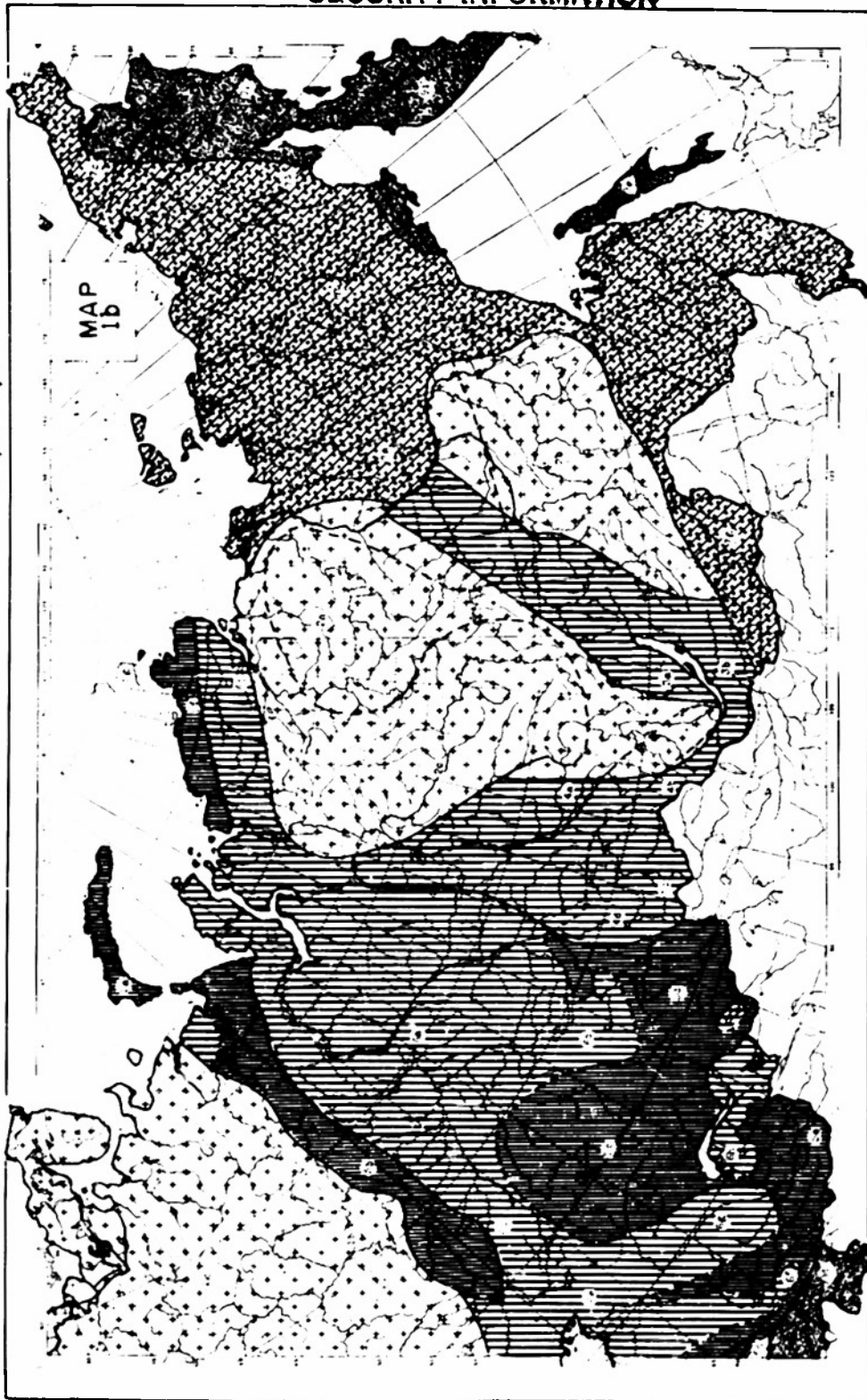
Approved: _____ Date: _____



GLACIAL MAP OF U.S.S.R. SCALE 1:32,000,000 CONIC

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MAP
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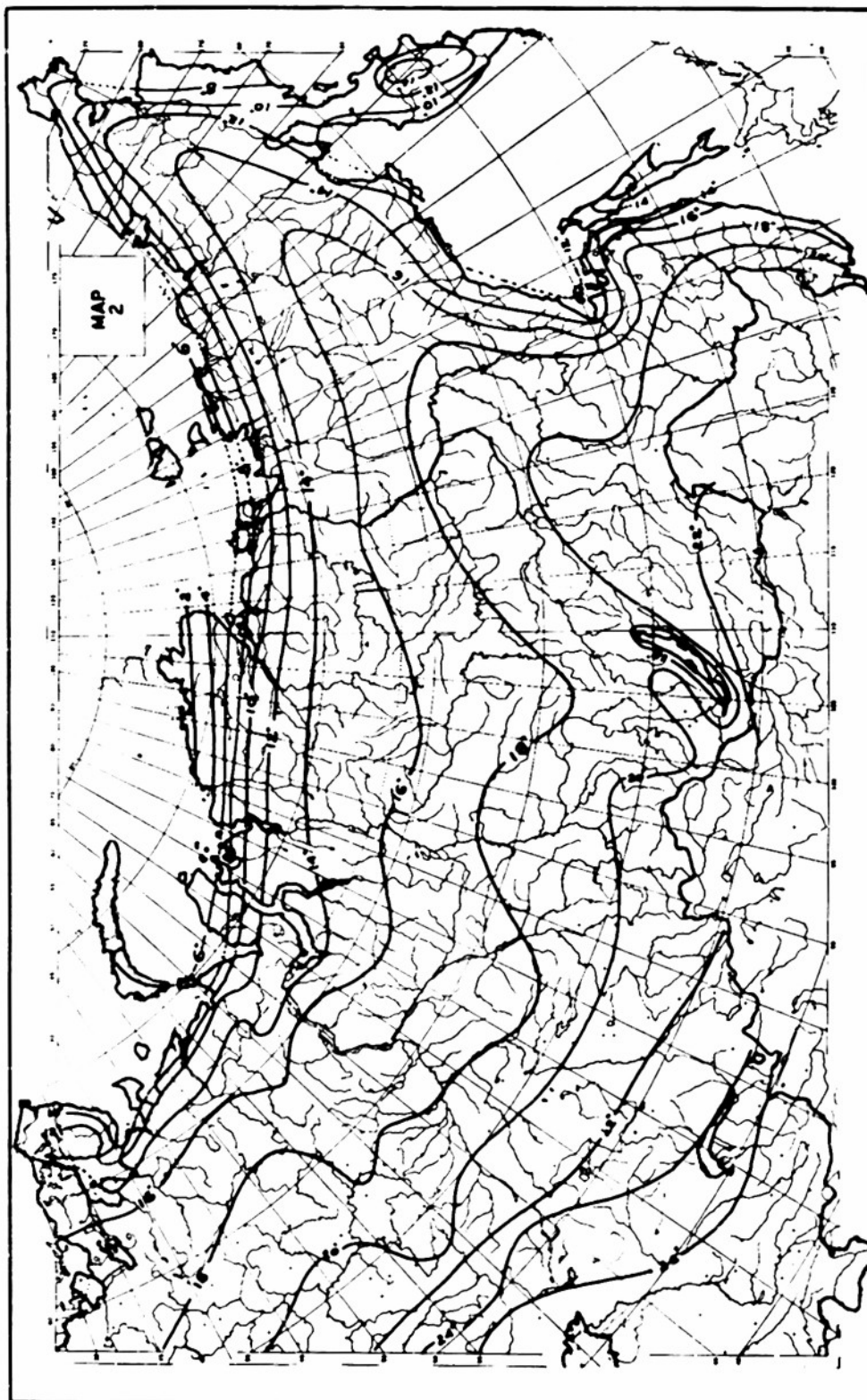


Geological	Stratigraphic	Location	Notes	Remarks
Pre-Cambrian Zone				
Middle Paleozoic (Cambrian) Zone				
Permian				
Triassic				
Jurassic				
Cretaceous				
Tertiary				
Quaternary				

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MEAN JULY TEMPERATURE (SEA - LEVEL) C°

SCALE 1:32,000,000 CONIC.

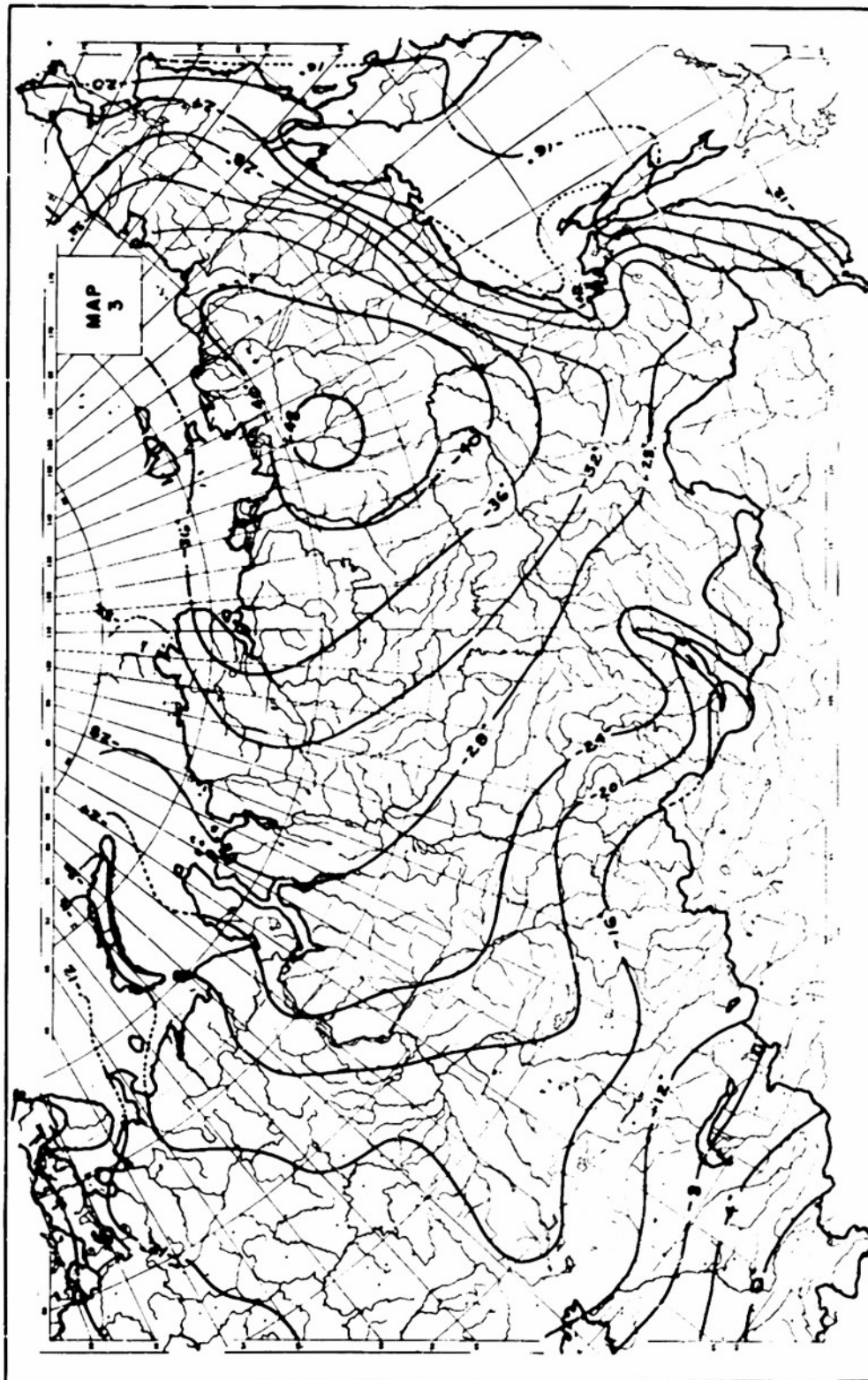


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MEAN JANUARY TEMPERATURE - SEA LEVEL C°

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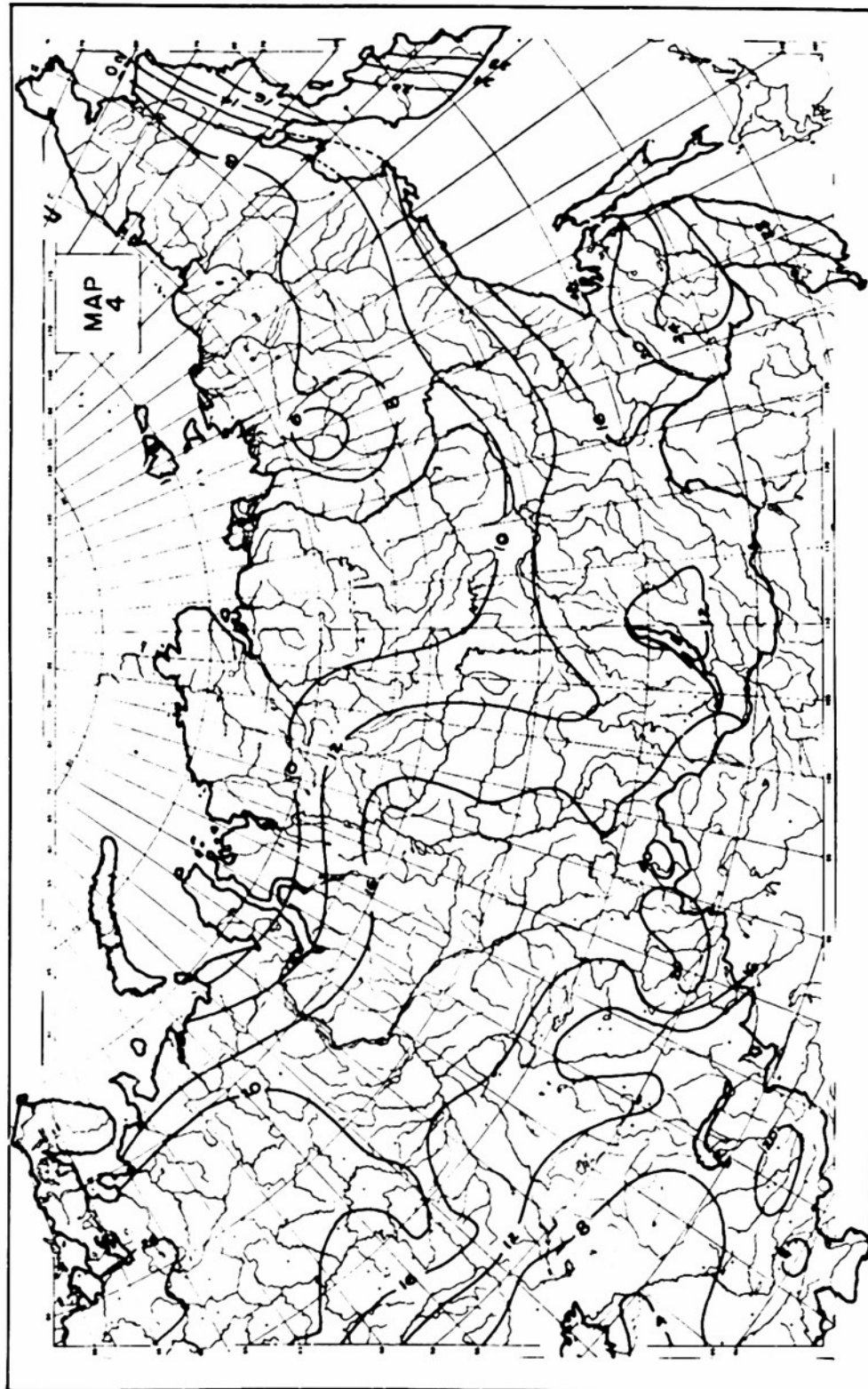


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MEAN ANNUAL PRECIPITATION - INCHES

SCALE 1:32,000,000 CONIC



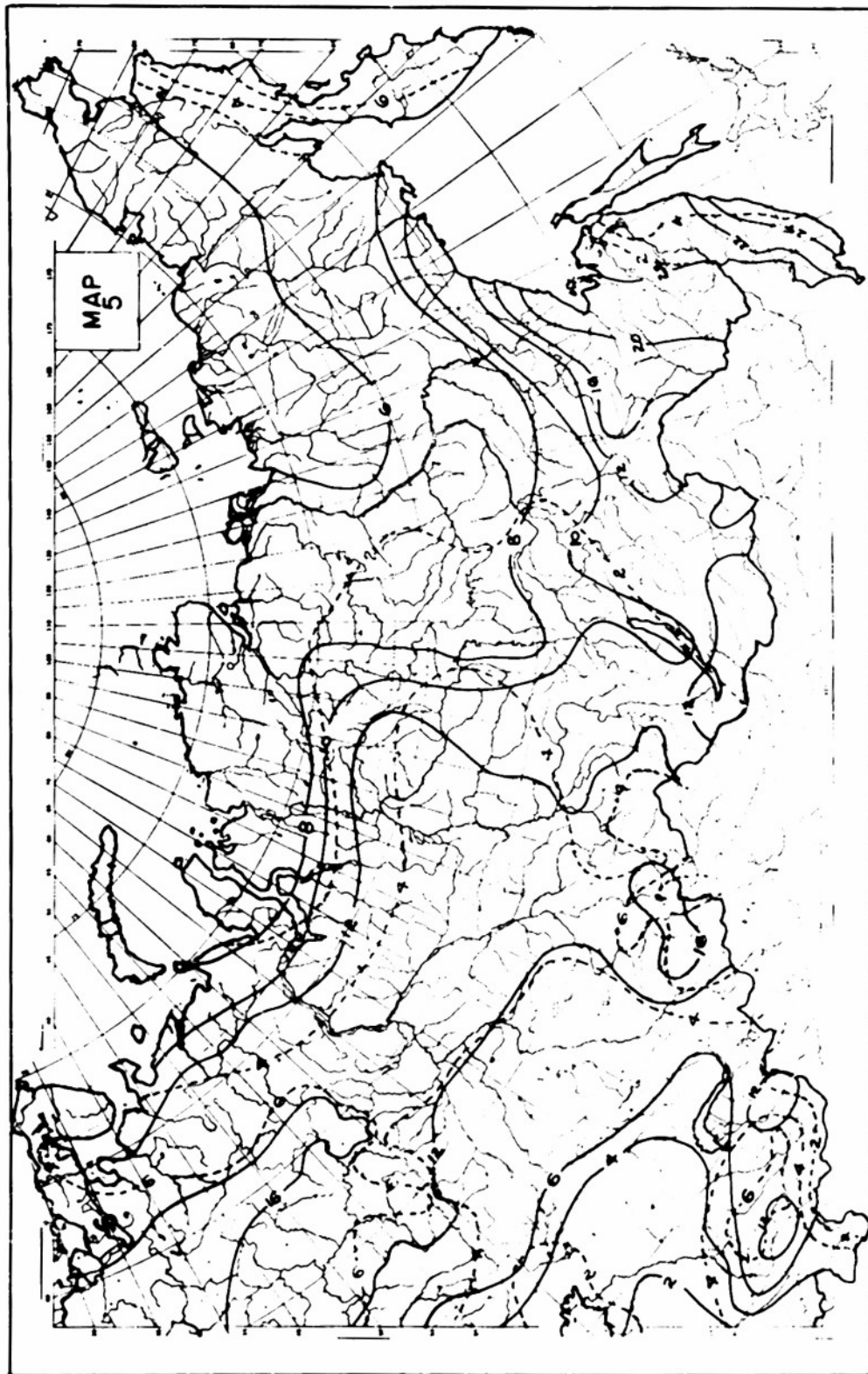
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EXTREMES OF SEASONAL PRECIPITATION - INCHES

SUMMER - FULL LINE WINTER - DASHED LINE

SCALE 1 : 12,000,000 CONIC




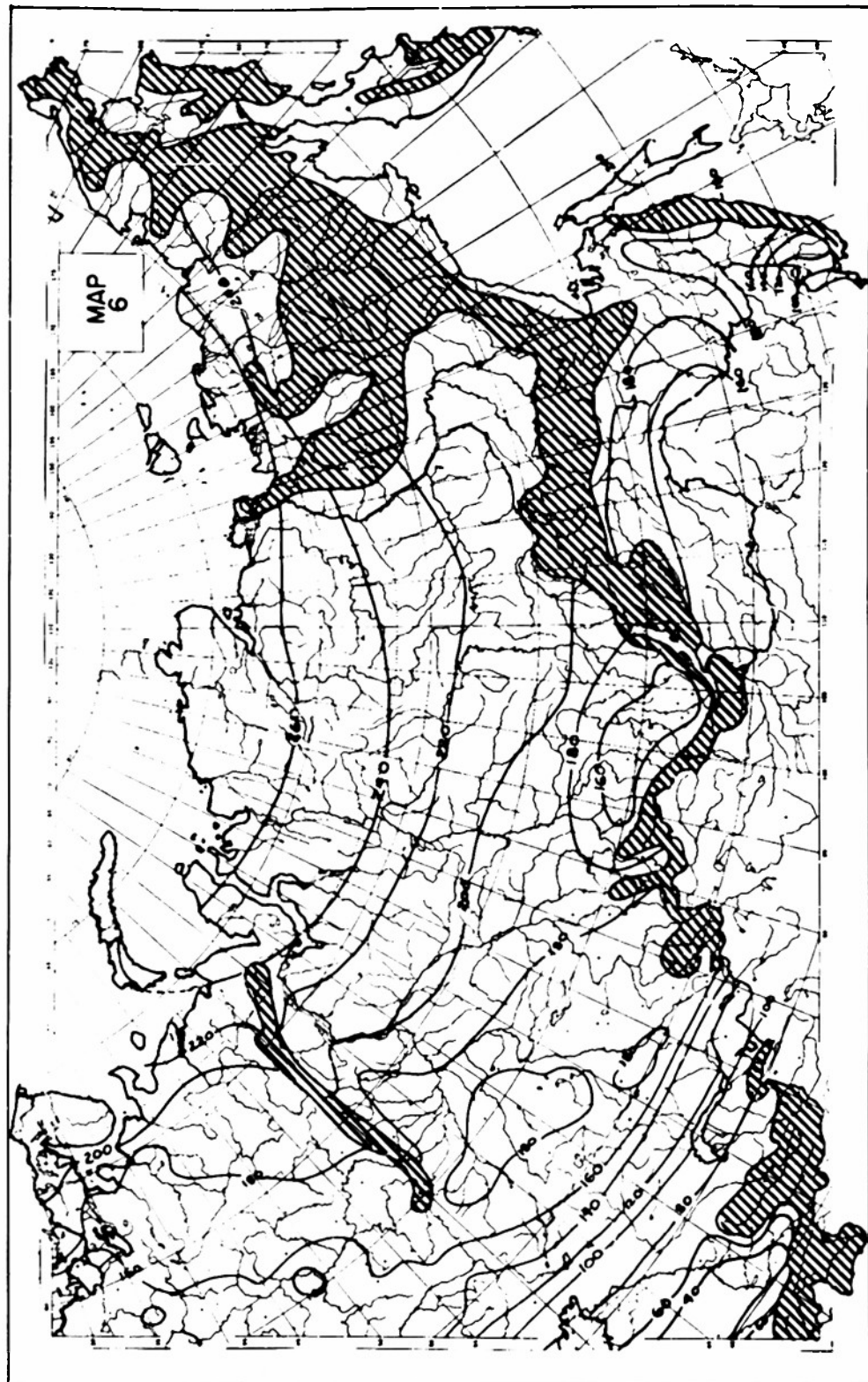
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DURATION OF SNOW IN DAYS

SCALE 1:32,000,000 CONIC


 MOUNTAIN REGIONS

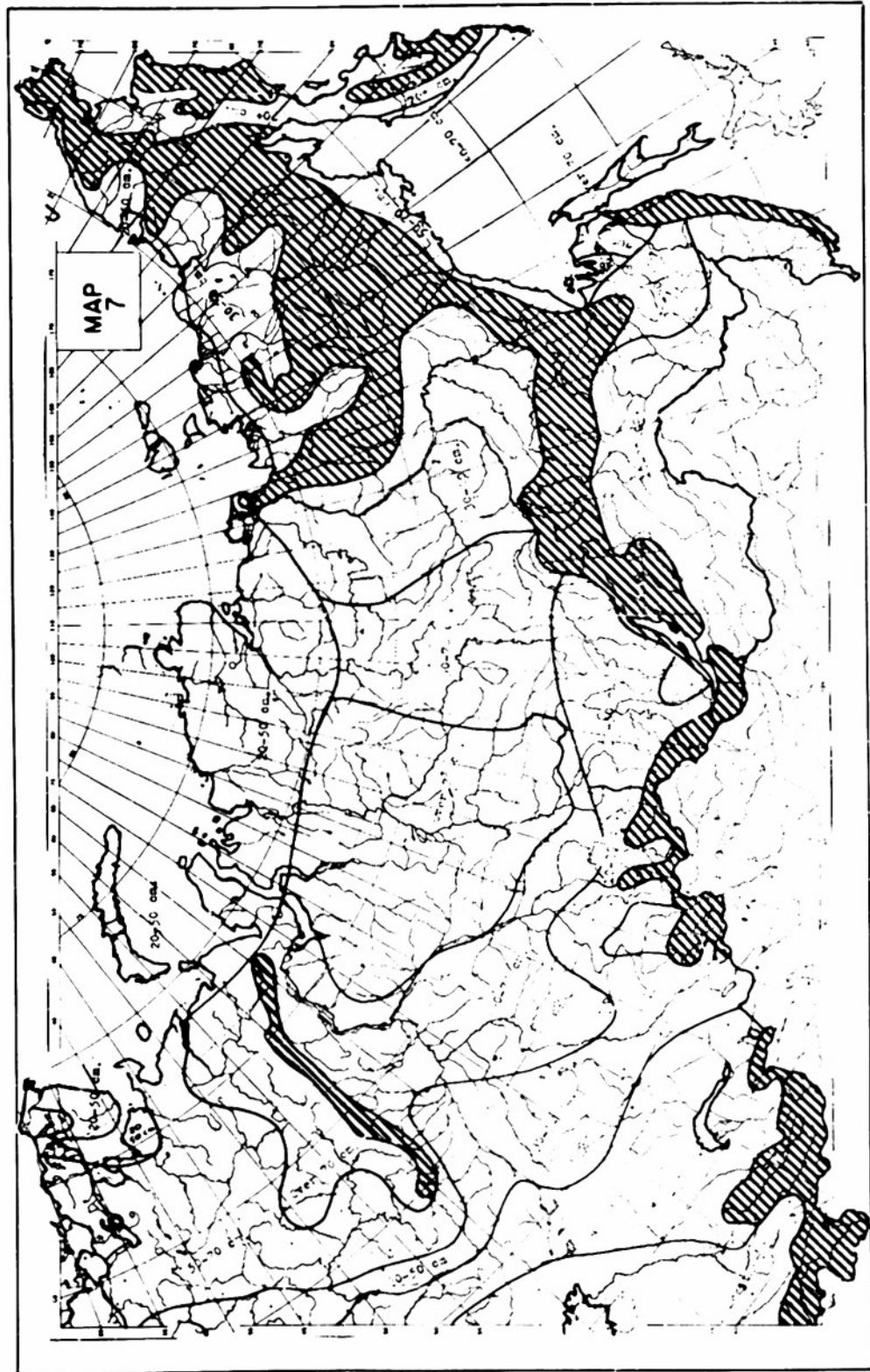


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SCALE 1 : 32,000,000 CONIC

 MOUNTAIN REGIONS

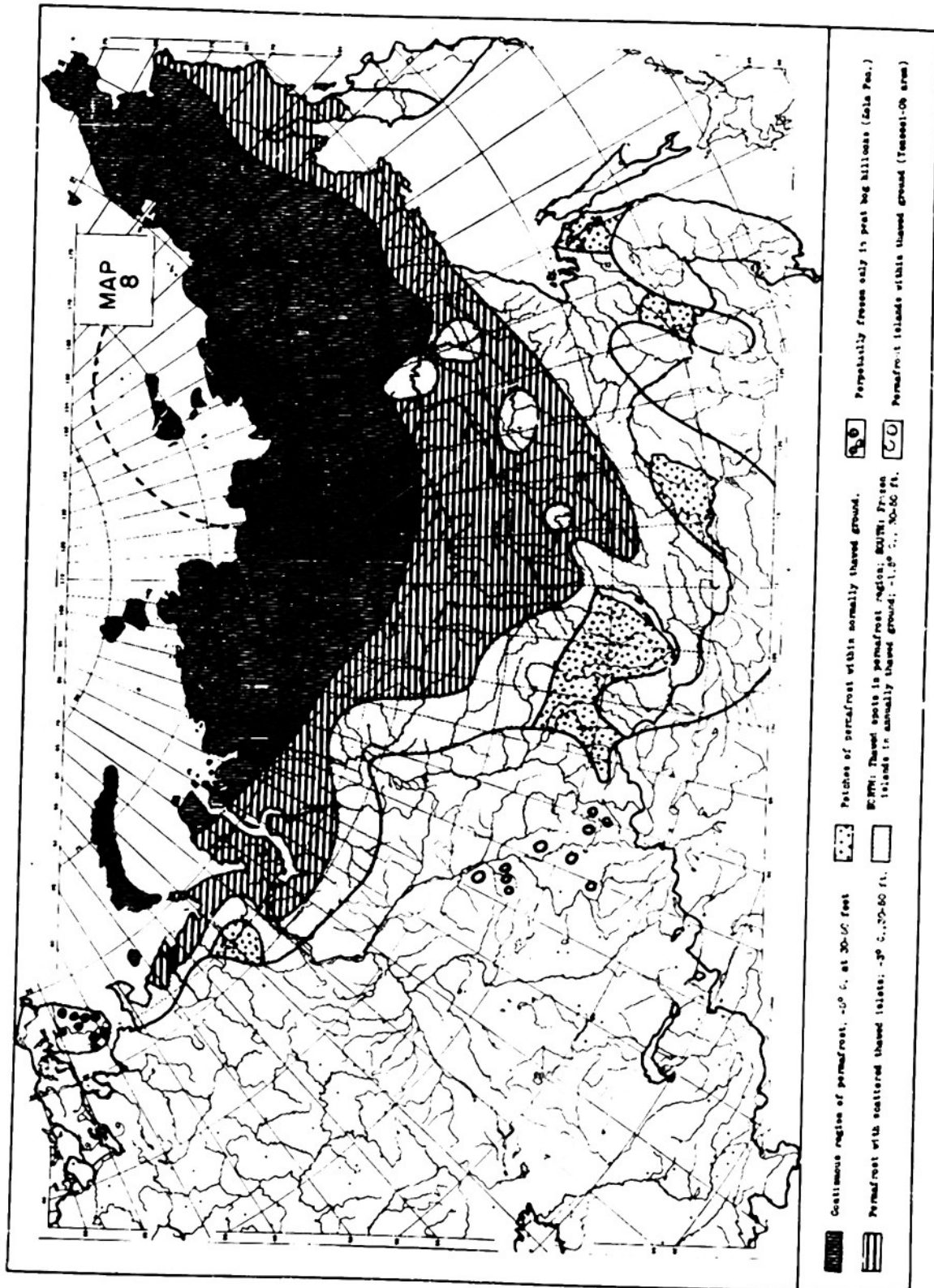


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PERMAFROST ZONES OF USSR

SCALE 1:32,000,000 CONIC

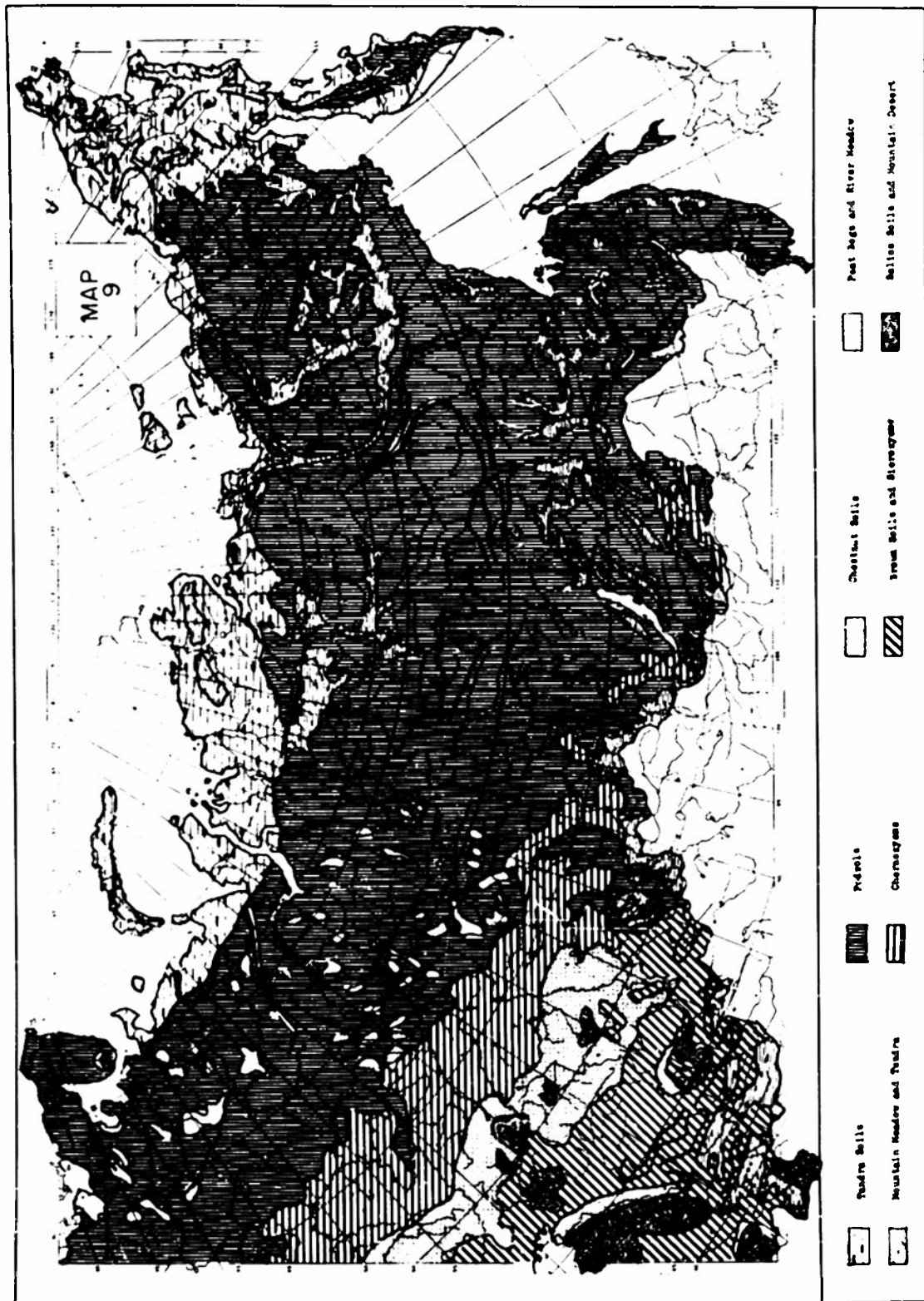


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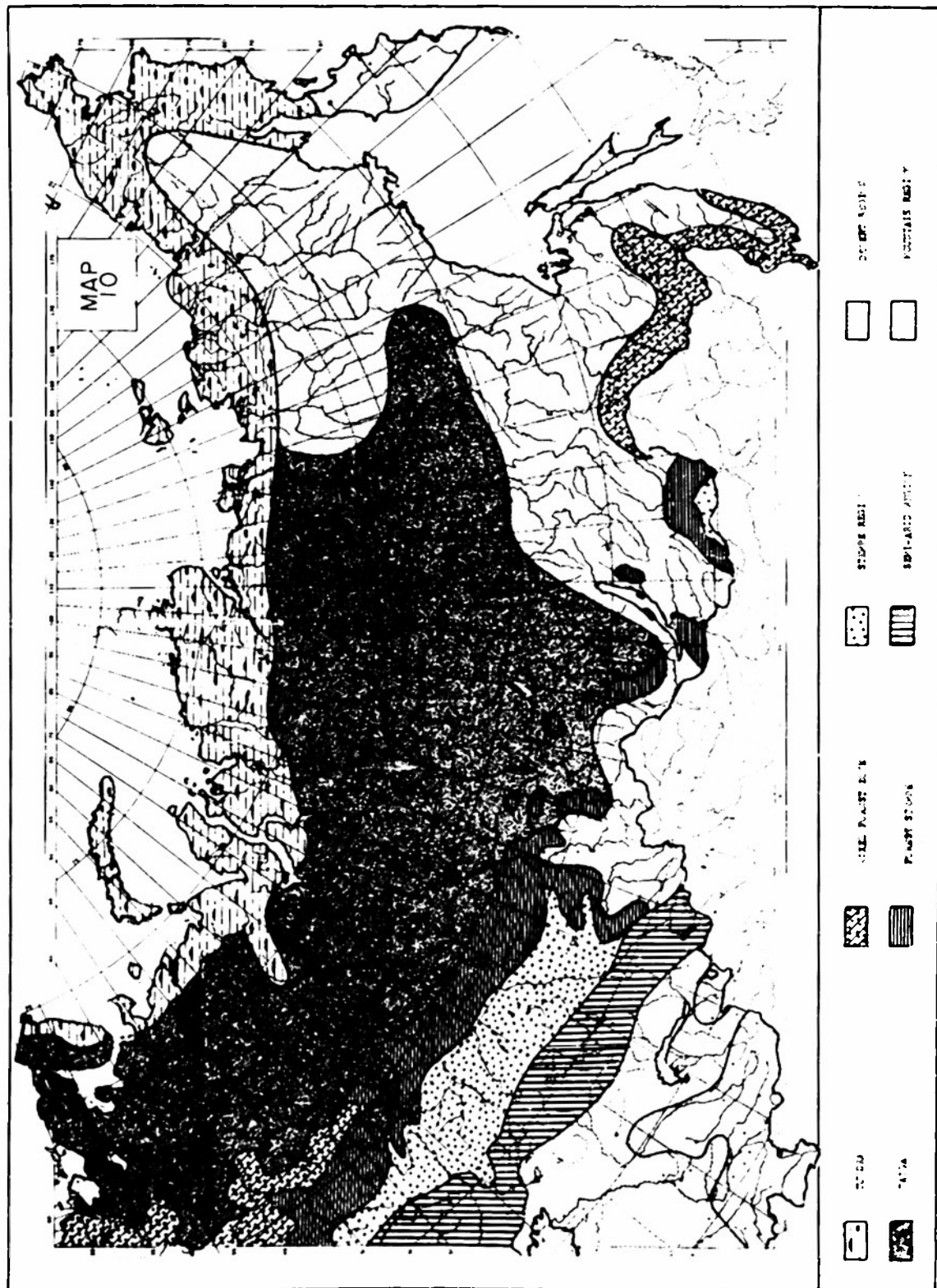
SOIL MAP OF U.S.S.R.
SCALE 1:32,000,000 CONIC



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SECURITY INFORMATION

SCALE 1: 32,000,000 CCNIC

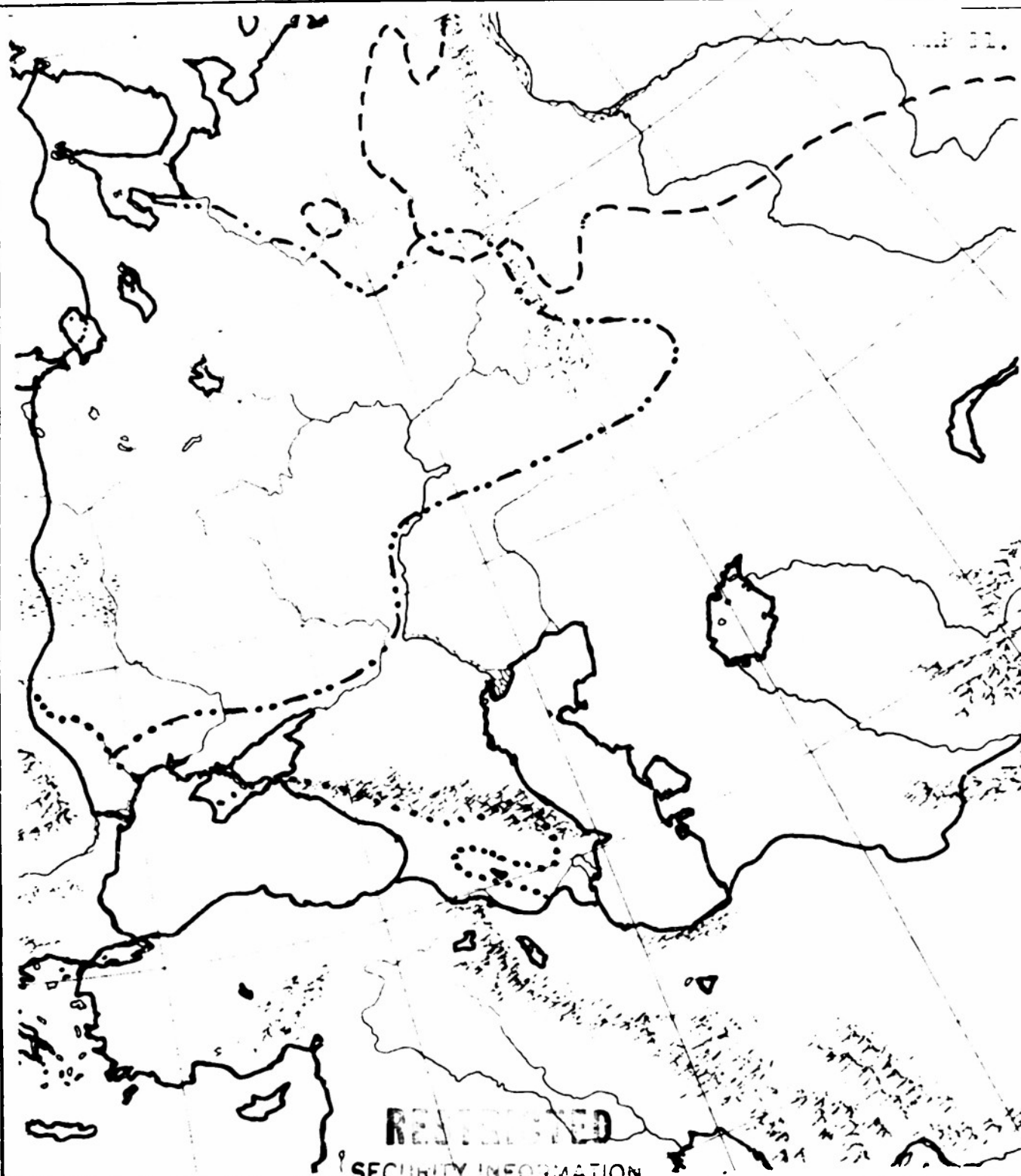


TREE LIMITS IN EUROPEAN RUSSIA

SCALE - 1:10,000,000 NAD 83

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- - - - - Western Limits, Siberian Stone Pine (*Pinus sibirica*)
- Eastern Limits of Alder (*Alnus glutinosa*)
- Eastern Limits of Birch (*Betula pubescens*)

TREE LIMITS IN EUROPEAN RUSSIA

SCALE - 1:20,000,000 Conic

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MAP 12



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- Eastern Limits of Oak (QUERCUS PEDUNCULATA)
- Eastern Limits of Linden (TILIA CORDATA)

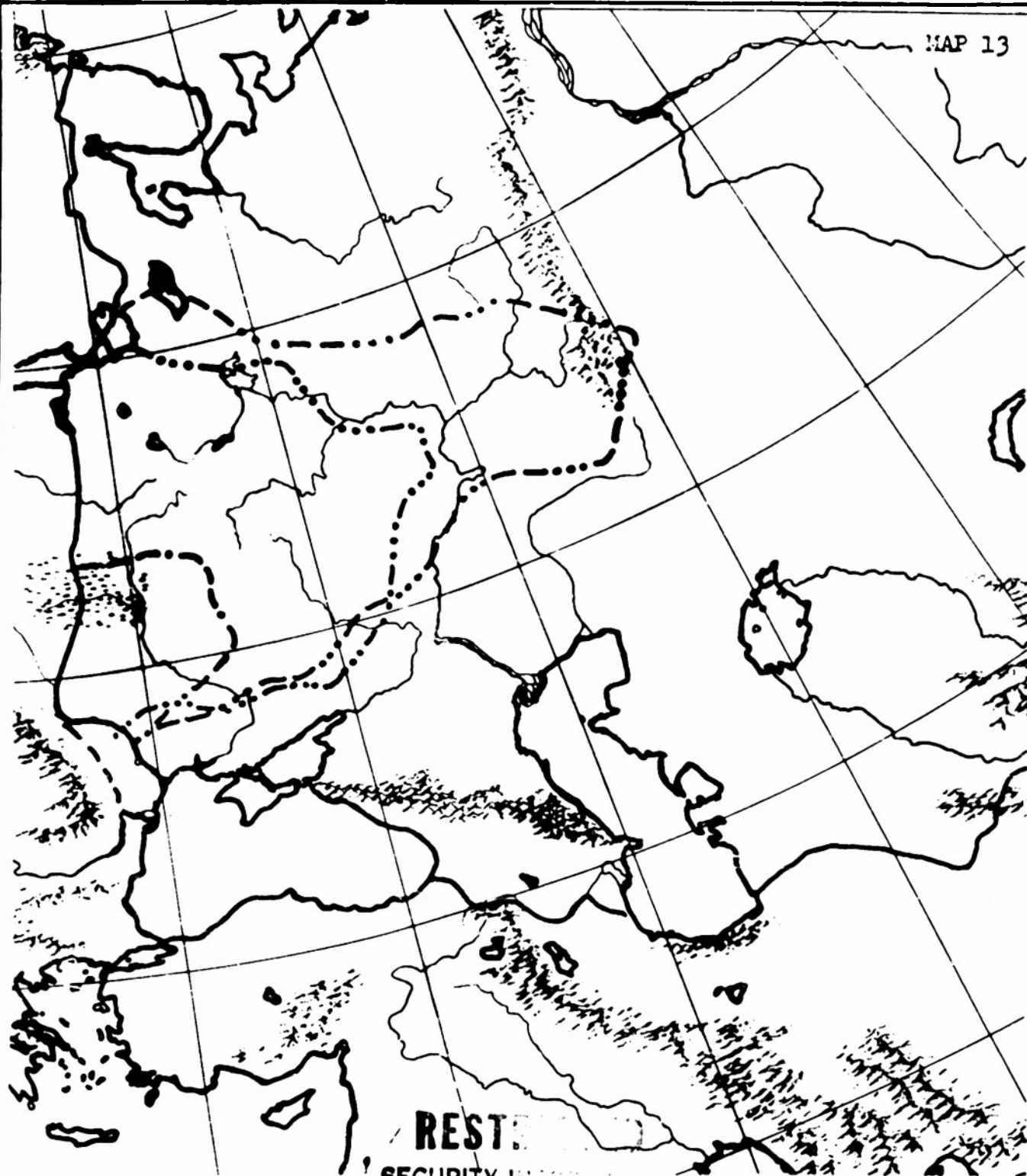
TREE LIMITS IN EUROPEAN RUSSIA

SCALE - 1:20,000,000 Conic

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MAP 13



REST.
SECURITY INFORMATION

- Eastern Limits of Maple (ACER PLATANOIDES)
- Eastern Limits of Ash (FRAXINUS EXCELSIOR)
- Eastern Limits of Hornbeam (CARPINUS BETULUS)

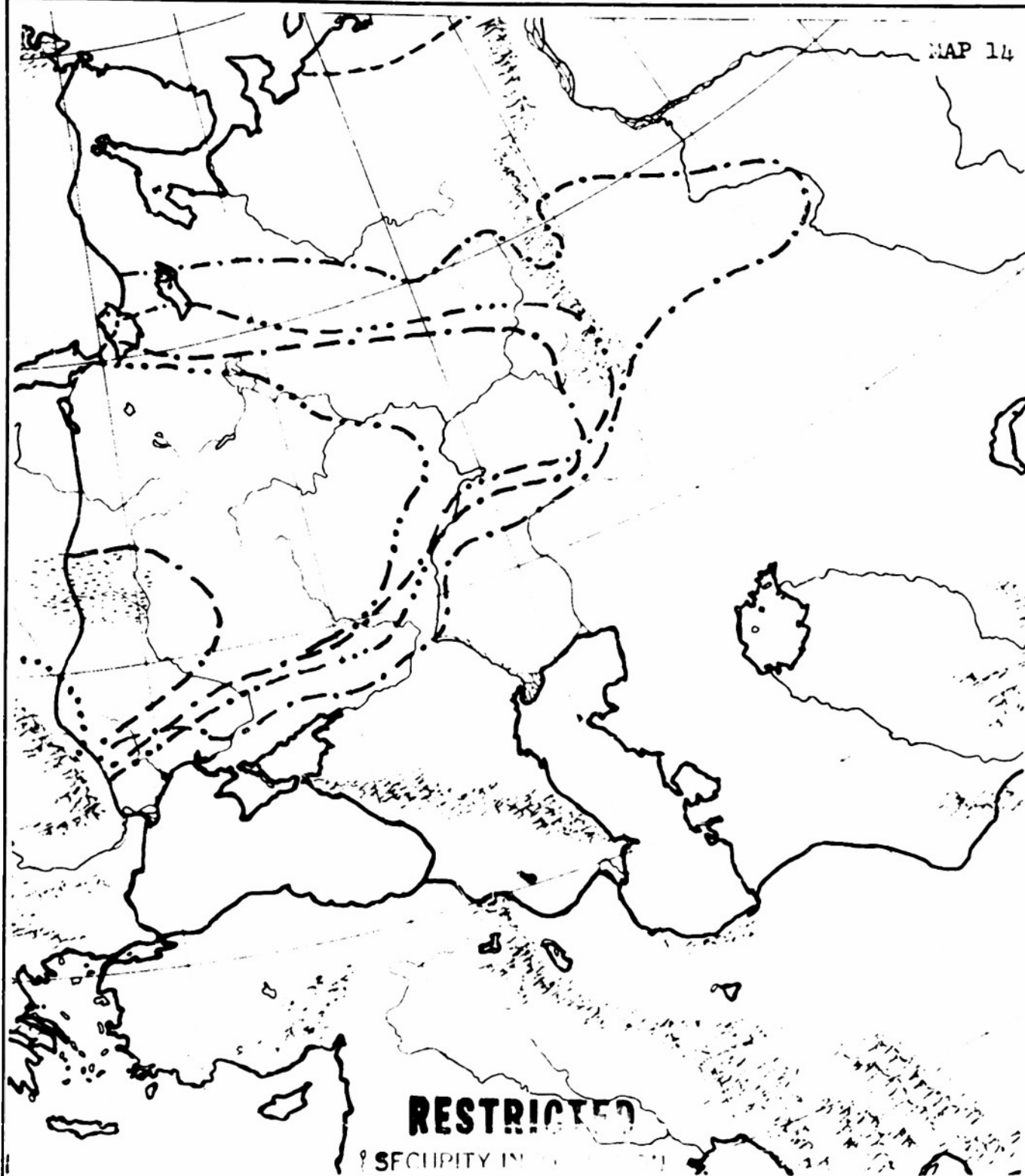
TREE LIMITS IN EUROPEAN RUSSIA

SCALE - 1:20,000,000 Conic

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MAP 14



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- Eastern Limits of Ash (FRAXUS EXCELSIOR)
- Eastern Limits of Beech (FAGUS SYLVATICA)
- Eastern Limits of Hornbeam (CARPINUS BETULINA)
- Eastern Limits of Linden (TILIA CORDATA)
- Eastern Limits of Maple (ACER PLATANOIDES)
- Eastern Limits of Oak (QUERCUS PEDUNCULATA)

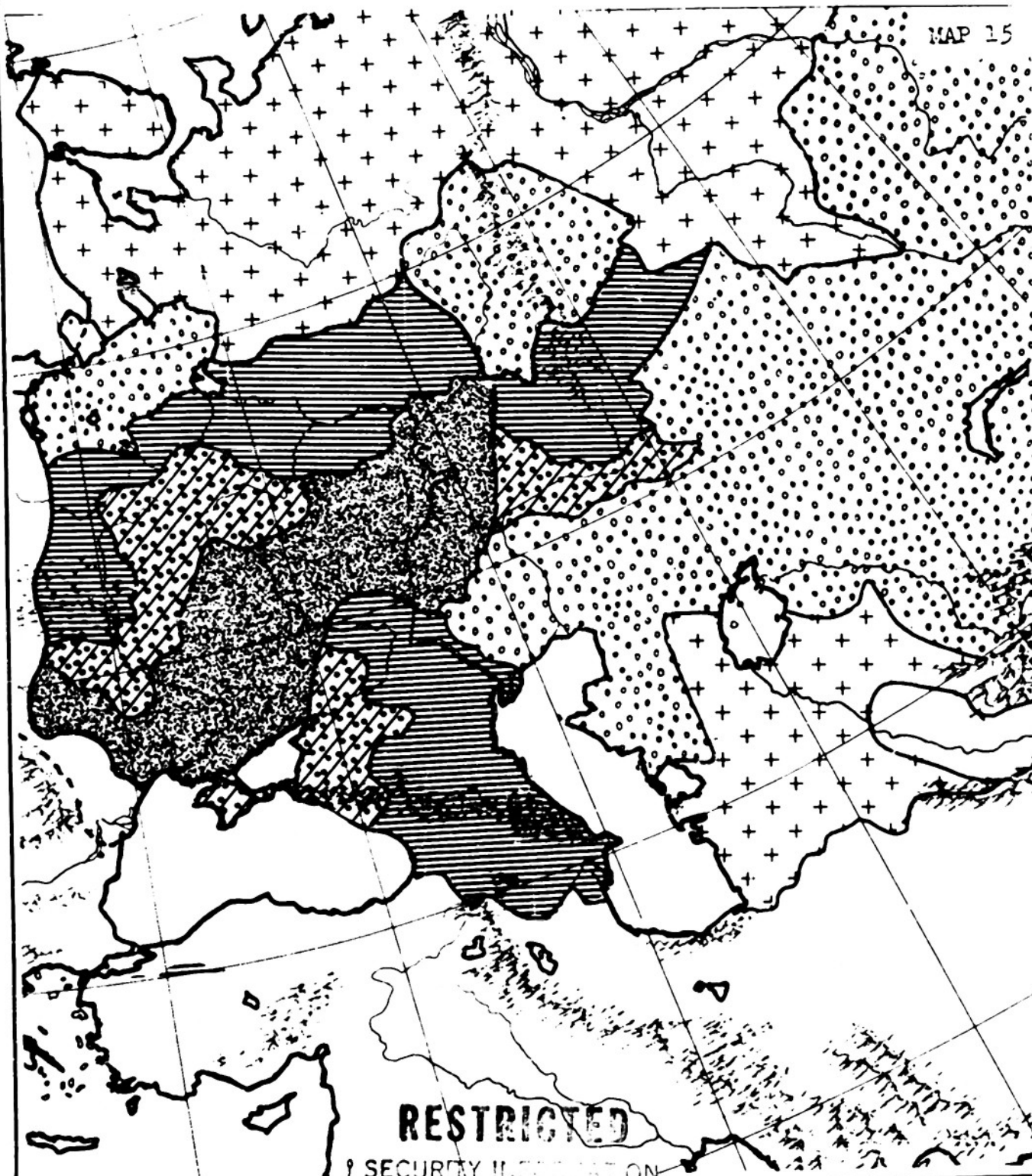
PERCENTAGE OF TOTAL LAND CULTIVATED, U.S.S.R. (After Balzak)

SCALE - 1:20,000,000 Conic

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MAP 15



0.5% - 5.0% Cultivated

20.0% - 40.0% Cultivated



60.0% - 80.0% Cultivated.



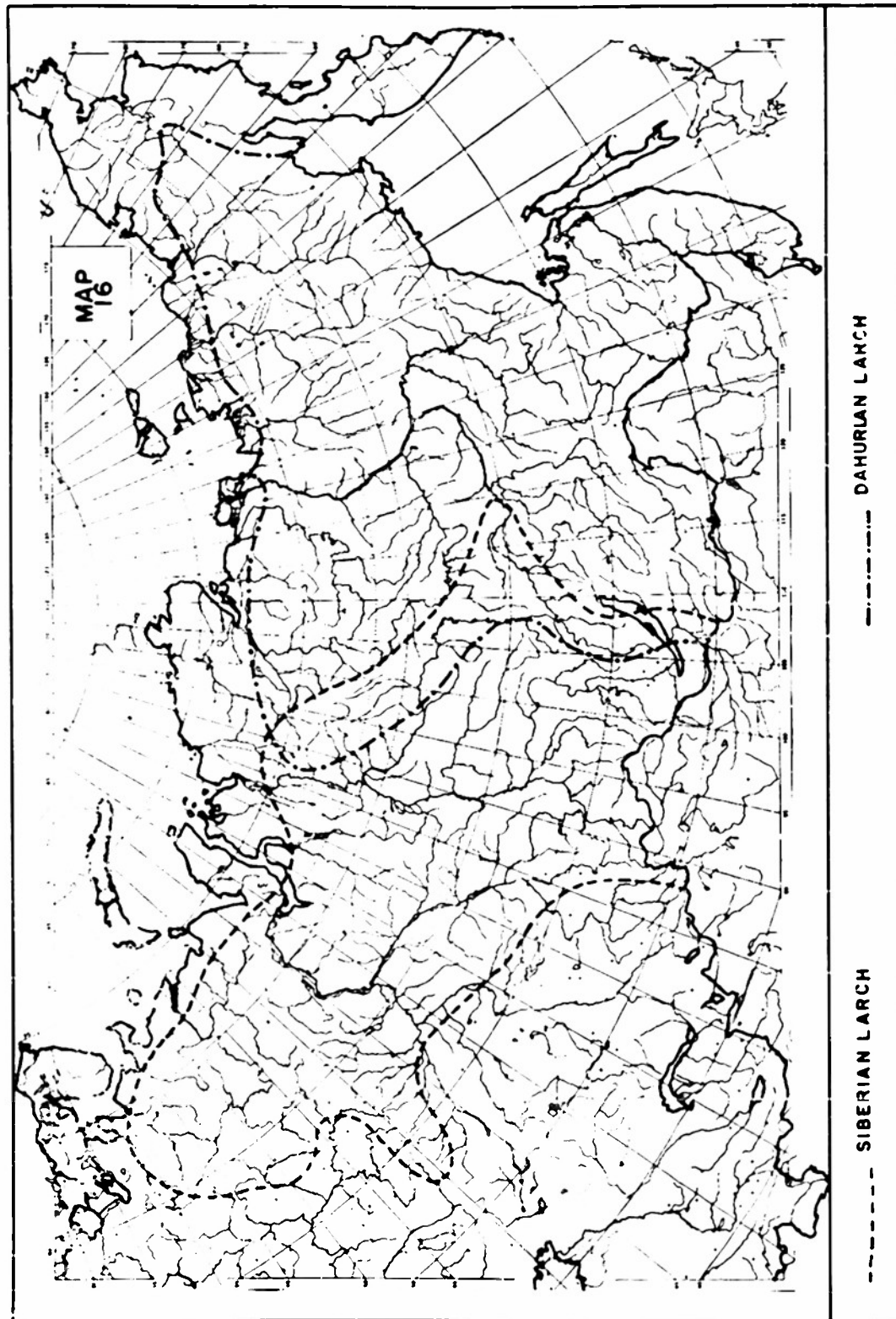
5.0% - 20.0% Cultivated

40.0% - 60.0% Cultivated

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TREE LIMITS - SIBERIA

SCALE 1:32,000,000 CONIC

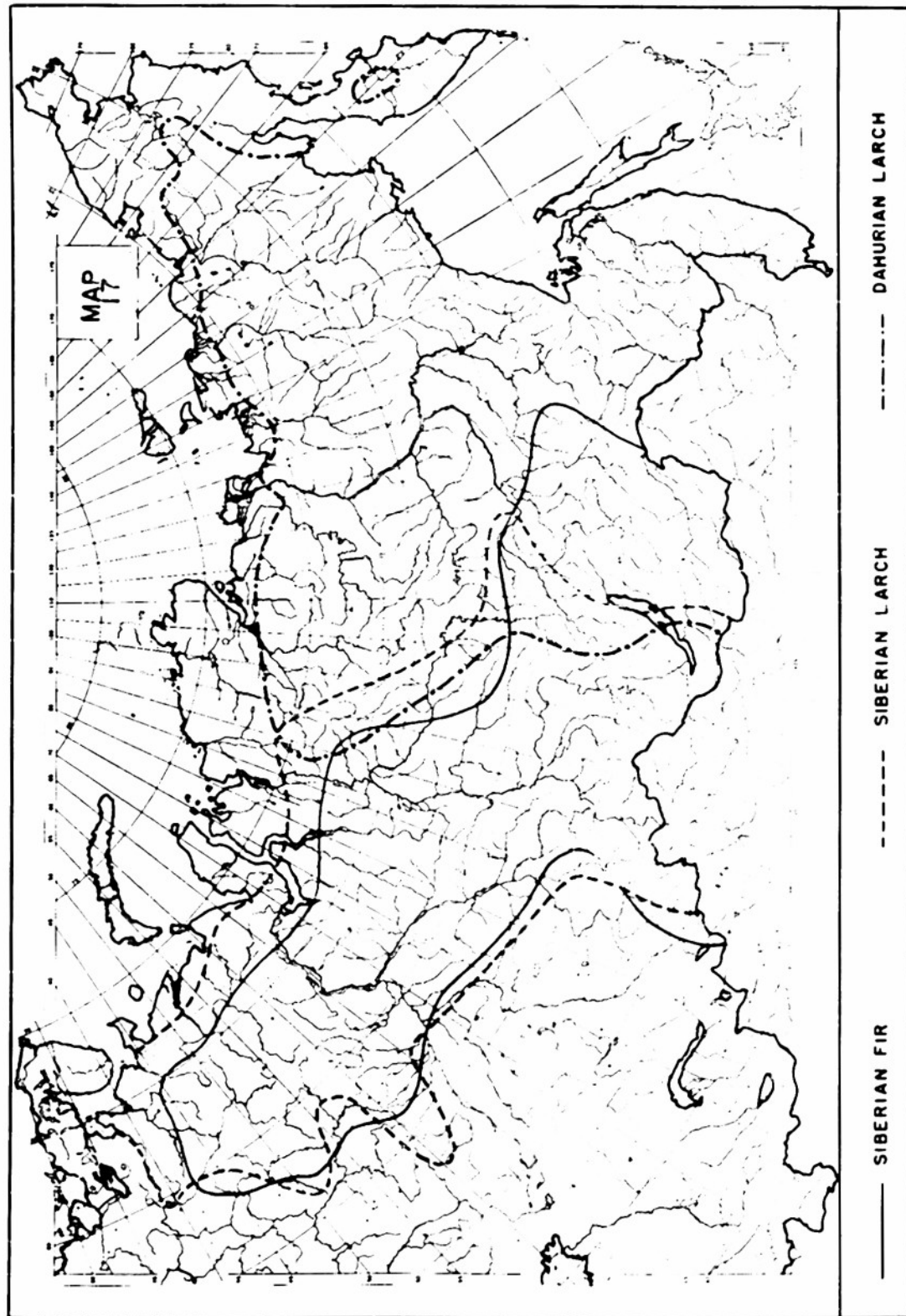


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TREE LIMITS - SIBERIA

SCALE 1:32,000,000 CONIC

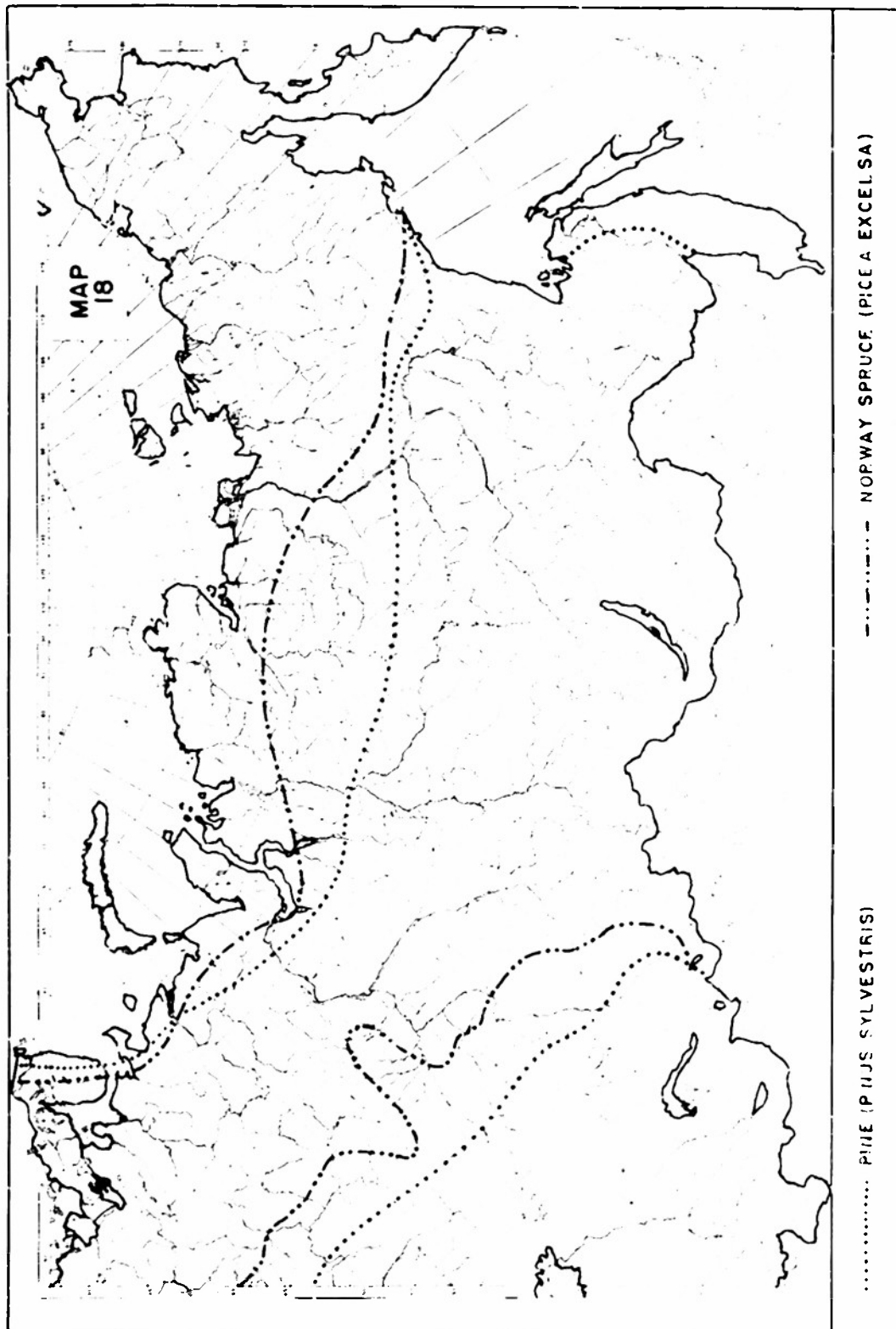


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TREE LIMITS - SIBERIA

SCALE 1:32,000,000 CONIC

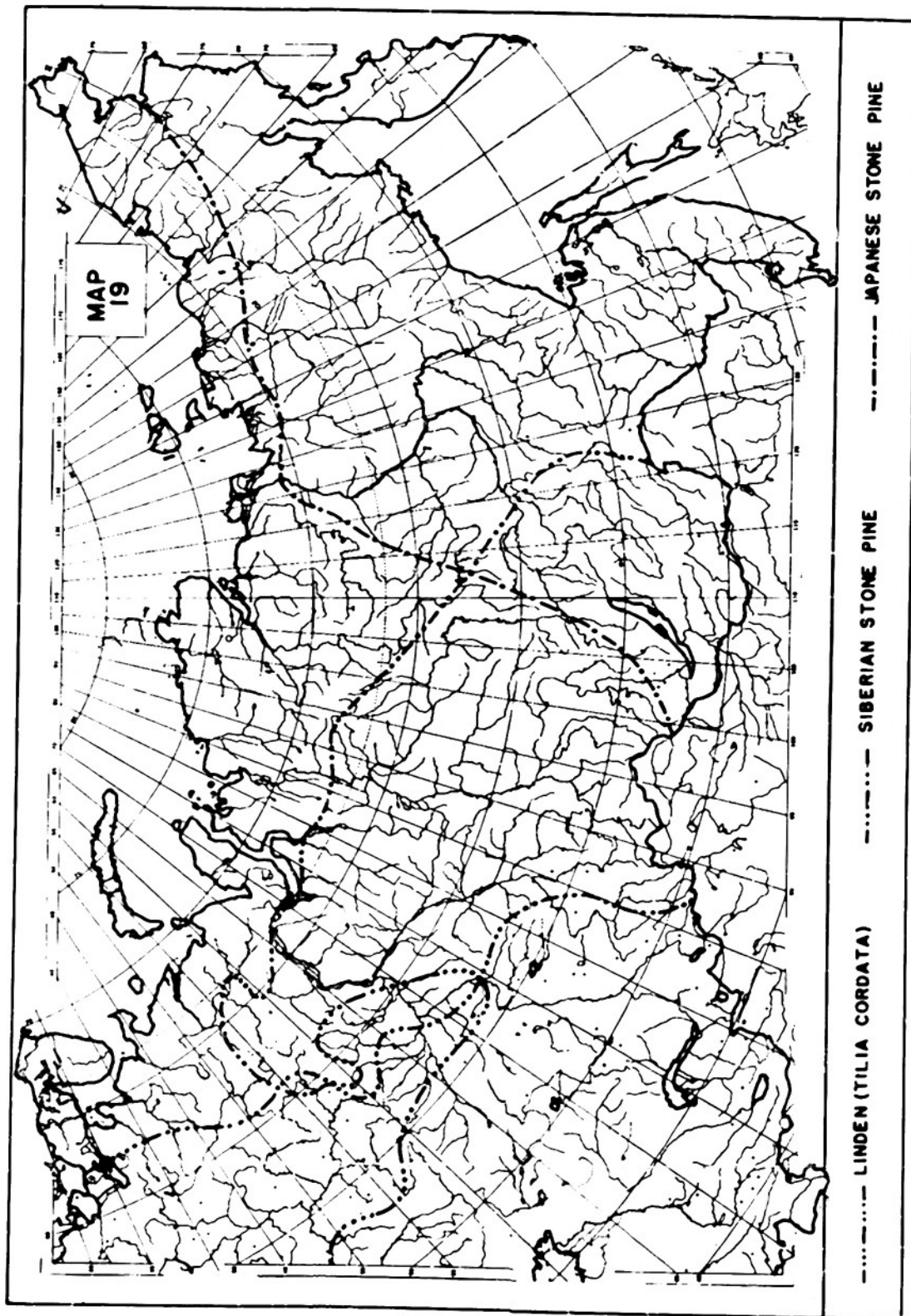


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TREE LIMITS - SIBERIA

SCALE 1:32,000,000 CONIC



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